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THE MAMMOTH CAVE AND ITS INHABITANTS.

BY THE EDITORS.

After the adjournment of the meeting of the American Association for the Advancement of Science, held at Indianapolis, in August last, a large number of the members availed themselves of the generous invitation of the Louisville and Nashville Railroad Company, to visit this world renowned cave, and examine its peculiar formation and singular fauna.

The cave is in a hill of the subcarboniferous limestone formation in Edmondson County, a little to the west and south of the centre of Kentucky. Green river, which rises to the eastward in about the centre of the state, flows westward passing in close proximity to the cave, and receiving its waters thence flows northwesterly to the Ohio.

The limestone formation in which the cave exists, is a most interesting and important geological formation, corresponding to the mountain limestone of the European geologists, and of considerable geological importance in the determination of the western coal fields.

We quote the following account of this formation from Major S. S. Lyon's report in the fourth volume of the Kentucky Geological Survey, pages 509–10.

"The sinks and basins at the head of Sinking creek exhibit in a striking manner, the eroding effect of rains and frost — some of the sinks, which are from forty to one hundred and ninety feet

deep, covering an area of from five acres to two thousand. The rim of sandstone surrounding these depressions is, generally, nearly level; the outcropping rocks within are also nearly horizontal. Near the centre there is an opening of from three to fifteen feet in diameter; into this opening the water which has fallen within the margin of the basin has been drained since the day when the rocks exposed within were raised above the drainage of the country, and thus, by the slow process of washing and weathering, the rocks, which once filled these cavities, have been worn and carried down into the subterranean drainage of the country. All this has evidently come to pass in the most quiet and regular manner. The size of the central opening is too small to admit extraordinary floods; nor is it possible, with the level margin around, to suppose that these cavities were worn by eddies in a current that swept the whole cavernous member of the subcarboniferous limestone of western Kentucky; but the opinion is probable that the upheaving force which raised these beds to their present level, at the same time ruptured and cracked the beds in certain lines; that afterwards the rains were swallowed into openings on these fractures, producing, by denudation, the basins of the sinkhole country, and further enlarging the original fractures by flowing through them, and thus forming a vast system of caverns, which surrounds the western coal field. The Mammoth Cave is, at present, the best known, and, therefore, the most remarkable."

So much has been written on the cave and its wonders, that to give a description of its interior would be superfluous in this connection, even could we do so without unintentionally giving too exaggerated statements which seems to be the natural result of a day underground, at least so far as this cave is concerned, for after reading any account of the cave, one is disappointed at finding the reality so unlike the picture. As the Association party was accompanied by one,* who while a most enthusiastic collector and explorer, was also a calm recorder of statements made by the geologists of the party, we can not do better in conveying to our readers the general geological character and structure of the cave than to copy his account.

"As we expected to remain within the cave a long time, our trusty guide, Frank, had provided himself with a well-filled can of oil, to replenish our lamps, and with this strapped upon his back he led the way into the thick darkness. We shall attempt no description of the cave. Its darkness must be felt to be appreciated, and no form of expression, understood by mortals who have never descended to its cavernous depths, nor trod its gloomy

*W. P. FISHBACK, Esq., of the Indianapolis Daily Journal.

corridors, can convey any thing like an adequate idea of the place. After spending fifteen hours within its chambers, it is absolutely nauseating to read the descriptions which have been current in the letters of newspaper correspondents for a quarter of a century, and even the vigorous and picturesque language of Bayard Taylor becomes tame and commonplace when it attempts to describe this subterranean wonder of the world.

How and when the cave was made, were the leading questions in the minds of the geologists. They do not believe that the cave was the immediate result of some violent upheaval of the strata, which left these vast crevices and chambers of which the cave is composed; neither do they share the popular belief that the rapid and violent action of some subterranean stream of water has worn these deep channels through the limestone; on the contrary, they find conclusive evidence that the same agencies are at work and the same changes in progress to-day that have been slowly, steadily and quietly, through vast periods of time, accomplishing the marvellous wonders that now astonish the beholder. The cave is wrought in the stratum known as the St. Louis limestone, which, in some places reaches a thickness or depth of four hundred feet. This stone is dissolved whenever it is subjected to the influence of running or dripping water impregnated with carbonic acid gas. Water exposed to the air readily absorbs this gas, and surface water percolating through small fissures of the limestone, dissolves it. Another fact should be stated. When, during this process of solution, the water becomes thoroughly impregnated with lime, it loses its power to dissolve the stone. The following conditions, then, were essential to the productions of the cave, assuming what is not disputed by geologists, that the place where the cave now is, was once nearly solid limestone. First, that there should be fissures in the strata, allowing the ingress of the surface water. Secondly, there should be a place or places of exit for the water charged with limestone in solution. Without the latter, the water would become charged with lime, fill up the crevices, and the dissolving process would cease. These conditions are all present to-day, and have remained the same during the countless ages that have passed away while the work has been in progress. There have doubtless been times in the history of the cave, when, owing to a greater flow of water, the work has progressed more rapidly than at present, but that the results have been accomplished in the manner stated, rather than by the process of attrition by rapid currents of large volumes of water, seems to be the general opinion of scientific men. This theory is strengthened by the fact that where the cave attains its greatest heights, and reaches its lowest depths, the dripping waters have never ceased their labors, and are busily at work to-day. In the Mammoth Dome, for instance — rarely seen by visitors, on account of the dangers and fatigue incident to the journey — where the chasm attains a height and depth of more

than two hundred and fifty feet, a cascade falls from a great height, and keeps the entire surface of the rocks covered with dripping water. This, falling into a deep pit below, finds an exit through which it bears away a portion of the lime composing the rock. After a walk of thirteen hours, our guide informed us that he would conduct us to the Mammoth Dome if we felt able to bear the fatigue of the journey. Foot-sore and weary, we were not in a favorable condition for so arduous an undertaking, but Mr. Thomas Kite of Cincinnati, who had visited the locality thirty years ago, urged us to go, and told us the sight of this Dome was worth all the rest. Provided with magnesium and calcium lights, we crawled and climbed our way to the brink of the pit, the bottom of which was reached by a rickety ladder, slippery and dripping with water. A portion of the party descended, and when all were ready the lights were ignited, and the immense dome was revealed to us in all its majestic beauty. Upon our return, three hearty cheers were given to the good friend at whose earnest solicitation we undertook this part of our journey.

We are indebted to Professor Alexander Winchell, of the University of Michigan, for the following abstract of his views concerning the formation of the cave.

'The country of the Mammoth Cave was probably dry land at the close of the coal period, and has remained such, with certain exceptions, through the Mesozoic and Cænozoic ages, and to the present. In Mesozoic times, fissures existed in the formation, and surface waters found their way through them, dissolving the limestone and continually enlarging the spaces. A cave of considerable dimensions probably existed during the prevalence of the continental glaciers over the northern hemisphere. On the dissolution of the glaciers, the flood of water which swept over the entire country, transporting the materials which constituted the modified drift, swept through the passages of the cave, enlarging them, and leaving deposited in the cave, some of the same quartzose pebbles which characterize the surface deposits from Lake Superior to the Gulf of Mexico. Since the subsidence of the waters of the Champlain epoch, the cave has probably undergone comparatively few changes. The well one hundred and ninety-eight feet deep, at the further end of the cave, shows where a considerable volume of the excavatory waters found exit. The Mammoth Dome indicates probably, both a place of exit and a place of entrance from above. So of the vertical passages in various other portions of the cave.'

We believe that the views of Professor Winchell are in harmony with those of the other eminent geologists of the party, and when it is considered that the geologists of this excursion stand in the front rank of the most eminent scientific men of the world, their views upon this interesting subject are well worthy of attention. Before dismissing this branch of the subject, we will take occasion

to correct a popular error concerning the formation of the beautiful structures that adorn the ceilings of some portions of the cave. In the drier localities, where the floors are dusty and everything indicates the prolonged absence of moisture, the ceiling is covered with a white efflorescence that displays itself in all manner of beautiful shapes. It requires no stretch of the imagination to discover among these, the perfect forms of many flowers. The lily form prevails, and the ceilings of many of the chambers are covered with this beautiful stucco work, surpassing in delicacy and purity the most beautiful workmanship of man. These are not produced, as many suppose, by the dripping of water, and the gradual deposit of sulphate of lime upon the outer portions. The stalactite is formed in this manner, but these are neither stalactiform, nor are they produced in a similar way. Dripping water is the agency that forms the stalactite, while the efflorescence in the dryer portions of the cave cannot take place where there is much moisture. The growth of these beautiful forms is from within, and the outer extremities are produced first. They are the result of a sweating process in the limestone that forces the delicate filaments of which they are composed through the pores upon the surface of the rock, their beautiful curved forms resulting from unequal pressure at the base, or friction in the apertures through which they are forced. Mr. L. S. Burbank, of Lowell, Mass., has kindly furnished us with the following abstract of his opinions upon this interesting subject.

'The rosettes, wreaths, and other curved fibrous forms of gypsum, in the Mammoth Cave, occur only in particular strata of the limestone which do not appear in the first part of the long route.

Their formation may be explained in this way: that portion of the rock where they are found consists of carbonate of lime, with some impurities, and contained originally the sulphide of iron, or iron pyrites, disseminated in small grains or crystals, and also in rounded nodules or concretions, sometimes of considerable size.

By exposure to air and moisture, oxygen unites with both the sulphur and the iron, producing sulphuric acid and oxide of iron, which combined, form a sulphate of iron. Then a double decomposition takes place; the sulphuric acid unites with the lime to form the gypsum; the carbonic acid of the limestone combines with the oxide of iron, forming a carbonate of iron, and this, on further exposure, parts with the carbonic acid, and leaves the brown coating of oxide, which is seen in many places on the surface of the rock.

The gypsum is thus constantly forming in the rock, and, being soluble, is carried by the water to the exposed surface where it crystallizes.

The crystals appear to grow out from the rock by additions from beneath, which continue to push the ends first formed, and if these do not become attached to other parts of the rock, straight needle-

like fibres are often produced. Very commonly, however, the crystals begin to form when a small nodule of the iron ore is exposed at the surface; the parts first formed become attached to the surface around the edges, and as the chemical action proceeds towards the centre of the nodules successive leaf-like layers are thrown out, and the rosette form is the result. Along lines of fracture in the surface of the rock, the crystals are curved in opposite directions.

The wreaths and other figures formed by the chains of the rosettes, may be caused by the chemical action described taking place around the edges of large masses or concretions of the iron ore.

These crystalline forms occur only in the dryer parts of the cave. Where there is more moisture, as in the 'Snow-ball room,' the gypsum merely forms white, rounded concretions, originating from nodules of the iron ore on the roof and sides of the cave.'"

With these general remarks on the cave we give a brief account of its interesting fauna, comprising representatives of the Fishes, Insects, and Crustaceans. No Mollusks or Radiates have as yet been discovered, but the lower forms of life have been detected by Tellkampf, who collected several species belonging to the genera *Monas*, *Chilomonas*, and (*?*) *Chilodon*.

On the Blind Fishes of the Cave. By F. W. Putnam.

[This part of the article is unavoidably postponed till the January number, as it was found necessary to illustrate it with two steel plates which could not be engraved in time for the present number.]

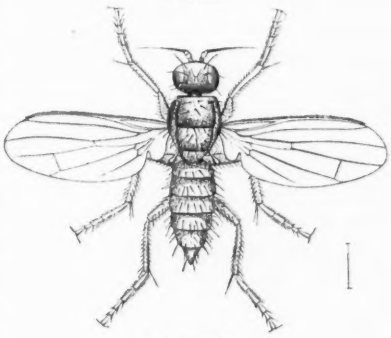
On the Crustaceans and Insects. By A. S. Packard, Jr.

Representatives of all the grand divisions of the Insects and Crustaceans have been found in this cave, and if no worms have yet been detected, one or more species would undoubtedly reward a thorough search.

We will enumerate what have been found, beginning with the higher forms. No Hymenoptera (bees, wasps, and ants) or Lepidoptera (moths) are yet recorded as being peculiar to caves. The Diptera (flies) are represented by two species, one of Anthomyia (Fig. 122), or a closely allied genus, and the second belonging to the singular and interesting genus Phora (Fig. 123). The species of Anthomyia usually frequent flowers; the larvæ live in decaying vegetable matter, or, like the onion fly, attack healthy roots. It would be presumptuous in the writer to attempt to describe these orms without collections of species from the neighborhood of the

cave, for though like all the rest of the insects they were found three or four miles from the mouth, yet they may be found to occur outside of its limits, as the eyes and the colors of the body are as bright as in other species.

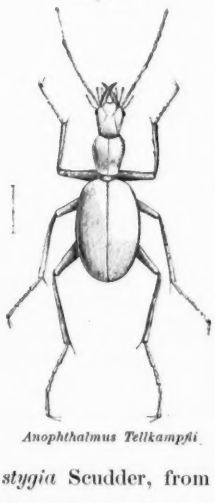
Fig. 122.



Anthomyia.

Among the beetles, two species were found by Mr. Cooke. The *Anopthalmus Tellkampfii* of Erichson, a Carabid (Fig. 124), and *Adelops hirtus* Tellkampf (Fig. 125) allied to Catops, one of the Silphidæ or burying beetle family. The Anopthalmus is of a pale reddish horn color, and is totally blind;* in the Adelops, which is greyish brown, there are two pale spots, which may be rudimentary eyes, as Tellkampf and Erichson suggest. No Hemiptera (bugs) have yet been found either in the caves of this country or Europe. Two wingless grasshoppers (sometimes called crickets) like the common species found under stones (*R. maculata* Harris), have been found in our caves; one is the *Raphidophora subterranea* (Fig. 126 nat. size) described by Mr. Scudder, and very abundant in Mammoth Cave. The other species is *R. stygia* Scudder, from Hickman's cave, near Hickman's landing,

Fig. 124.



Anophthalmus Tellkampfii.

Fig. 123.

Phora.

Fig. 125.

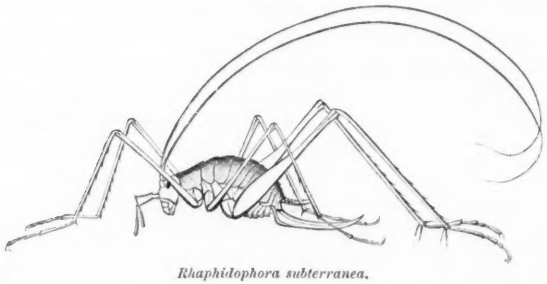
Adelops hirtus.

* In Erhardt's cave, Montgomery Co., Virginia, Prof. Cope found "four or five specimens of a new Anopthalmus, the *A. pusio* of Horn, at a distance of not more than three hundred feet from its mouth. The species is small, and all were found together under a stone. Their movements were slow, in considerable contrast to the activity of ordinary Carabidæ." Proc. Amer. Phil. Soc. 1869. p. 178.

upon the Kentucky river. It is closely allied to the Mammoth Cave species. According to Mr. Scudder, the specimens of *R. stygia* were found by Mr. A. Hyatt "in the remotest corner of Hickman's Cave, in a sort of a hollow in the rock, not particularly moist, but having only a sort of cave dampness. They were found a few hundred feet from the sunlight, living exclusively upon the walls." Even the remotest part of that cave is not so gloomy but that some sunlight penetrates it.

The other species is found both in Mammoth Cave, and in the adjoining White's Cave. It is found throughout the cave, and most commonly (to quote Mr. Scudder) "about 'Martha's Vineyard' and in the neighborhood of 'Richardson's Spring' where they were discovered jumping about with the greatest alacrity

Fig. 126.



Rhaphidophora subterranea.

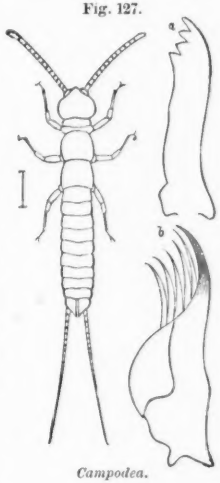
upon the walls, where only they are found, and even when disturbed, clinging to the ceiling, upon which they walked easily; they would leap away from approaching footsteps, but stop at a cessation of the noise, turning about and swaying their long antennæ in a most ludicrous manner, in the direction whence the disturbance had proceeded; the least noise would increase their tremulousness, while they were unconcerned at distant motions, unaccompanied by sound, even though producing a sensible current of air; neither did the light of the lamp appear to disturb them; their eyes, and those of the succeeding species (*R. stygia*) are perfectly formed throughout, and they could apparently see with ease, for they jump away from the slowly approaching hand, so as to necessitate rapidity of motion in seizing them."

The Thysanurous Neuroptera are represented by a species of Machilis, allied to our common *Machilis variabilis* Say, common in Kentucky and the middle and southern states. So far as Tell-

kampf's figure indicates, it is the same species apparently, as I have received numerous specimens of this widely distributed form from Lexington, Kentucky, collected by Dr. Josiah Curtis.

It was regarded as a crustacean by Tellkampf, and described under the name of *Trinra cavernicola*.* He mistook the labial and maxillary palpi for feet and regarded the nine pairs of abdominal spines as feet. The allied species, *M. variabilis* Say, is figured in vol. v. pl. 1, fig. 8, 9 (see also p. 94 of this journal).

Fig. 127.



Campodea.

An interesting species of Campodea† of which the accompanying cut (Fig. 127) is a tolerable likeness, though designed to illustrate another species (*C. staphylinus* Westw.) was discovered by Mr. Cooke. Both the European and our common species live under stones in damp places, and the occurrence of this form in the water is quite remarkable. The other species are blind, and I could detect no eyes in the Mammoth Cave specimen.

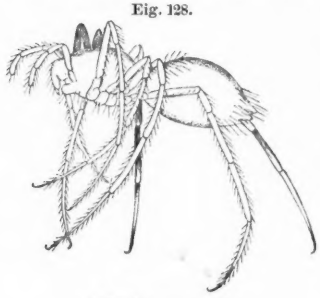
A small spider was captured by Mr. Cooke, but afterwards lost; it was brown in color, and possibly distinct from the *Anthrobia monmouthia* Tellkf. (Fig. 128) which is an eyeless form, white and very small, being but half a line in length. The family

* Professor Agassiz in his brief notice of the Mammoth Cave animals, does not criticise Tellkampf's reference of this animal to the crustacea; and so eminent an authority upon the articulates as Schiödte remarks that while "Dr. Tellkampf's account affords us no means of forming any conclusion as to its proximate relations," that, however, it "appears to belong to the order of Amphipoda, and to have a most remarkable structure." Tellkampf's figure of Machilis is entirely wrong in representing the labial and maxillary palpi as ending in claws, thus giving the creature a crustacean aspect; and indeed he describes them as true feet!

† *Campodea Cookei* n. sp. Closely allied to *C. Americana*, but it is much larger; the antennæ are 24-jointed instead of 20-jointed as in *C. Americana*, and reach to the basal abdominal segment, while in *C. Americana* they reach only to the second thoracic; the terminal joints are much longer than in that species, the penultimate joint being one-third longer. Last three abdominal segments unequal (equal in *C. Americana*) the penultimate very short, not half as long as the terminal, which is longer and slenderer than in *C. Americana*, while the three are much narrower in proportion to the rest of the body than in the other species. Hind femora longer than in *C. Americana*. Entirely white and pilose. Length .25 inch, the largest *C. Americana* being .15 to .20 inch. (Anal stylets broken off.) Several specimens were seen by Mr. C. Cooke, but only one was captured in a pool of water, two or three inches deep, in company with the Cæcidotea.

of Harvest men is represented by a small white form, described by Tellkampf under the name of *Phalangodes armata* (Fig. 129) but now called *Acanthocheir armata* Lucas. The body alone is but half a line long, the legs measuring two lines. It should be borne in mind that many of the spiders, as well as the Thysanura, live in holes and dark places, so that we would naturally find them in caves. So, also, with the Myriopods, of which a most remarkable form* (Figs. 130, and 130*a* front of head) was found by Mr. Cooke, three or four miles from the mouth of the cave. It is the only truly hairy species known, an approach to it being found in *Pseudotremia Vudii* Cope. It is blind, the other species of this group which Professor Cope found living in caves having eyes. The long hairs arranged along the back, seem to suggest that they are tactile organs, and of more use to the Thousand legs in making its way about the nooks and crannies of a perpetually dark cave than eyes would be. It was found by Mr. Cooke under a stone.

Fig. 128.



Anthrobia monmouthia.

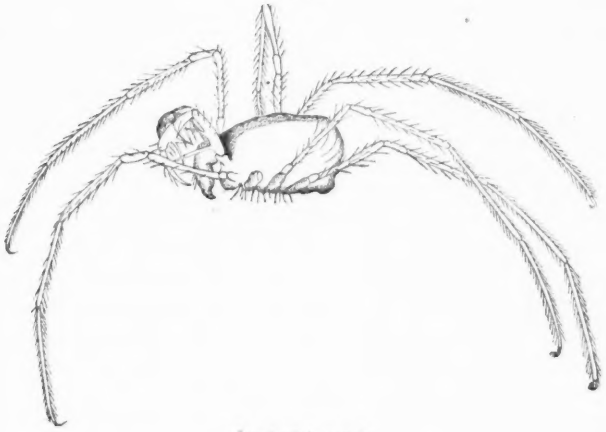
Prof. Cope has contributed to the "Proceedings of the American Philosophical Society" (1869, p. 171) an interesting account of the

* *Spirostrephon* (*Pseudotremia*) *Copei* n. sp. Head with rather short, dense hairs; no eyes, and no ocular depression behind the antennæ, the surface of the epicranium being well rounded to the antennal sockets; behind the insertion of the antennæ the sides of the head are much more swollen than in *S. lactarius*. Antennæ slender, with short thick hairs; relative length of joints, the 6th being longest; 6th, 4th, 5th, 3d, 8th, 7th, 1st, the 7th joint being much thicker than the 8th. Twenty-eight segments besides the head; they are entirely smooth, striated neither longitudinally nor transversely; a few of the anterior segments rapidly decrease in diameter towards the head. The segments are but slightly convex, and on each side is a shoulder, bearing three tubercles in a transverse row, each giving rise to a long stiff hair one-half to two-thirds as long as the segment is thick; these hairs stand up thickly all over the back, and may serve at once to distinguish the species. No pores. Feet long and slender, nearly as long as the antennæ, being very slender towards the claws. Entirely white. Length of body .35 inch; thickness .04 inch.

It is nearly allied to *Pseudotremia Vudii* of Cope. It will be noticed that Professor Cope characterizes the genus Spirostrephon as having "no pores"; though we find it difficult to reconcile this statement with that of Wood who describes *S. lactarius* as having "lateral pores." Cope separates Pseudotremia from Spirostrephon for the reason that the segments have "two pores on each side the median line." The present species has no pores, but seems in other characters to be a true Spirostrephon, and we are thus led to doubt whether Pseudotremia is a well founded genus.

cave mammals, articulates and shells of the middle states. He says that "myriopods are the only articulates which can be readily found in the remote regions of the caves [of West Virginia] and they are not very common in a living state." The *Pseudotremia cavernarum* which he describes, "inhabits the deep-

Fig. 129.



Acanthocheir armata.

est recesses of the numerous caves which abound in Southern Virginia, as far as human steps can penetrate. I have not seen it near their mouths, though its eyes are not undeveloped, or smaller than those of many living in the forest. Judging from its remains, which one finds under stones, it is an abundant species, though

Fig. 130. Fig. 130*a*.

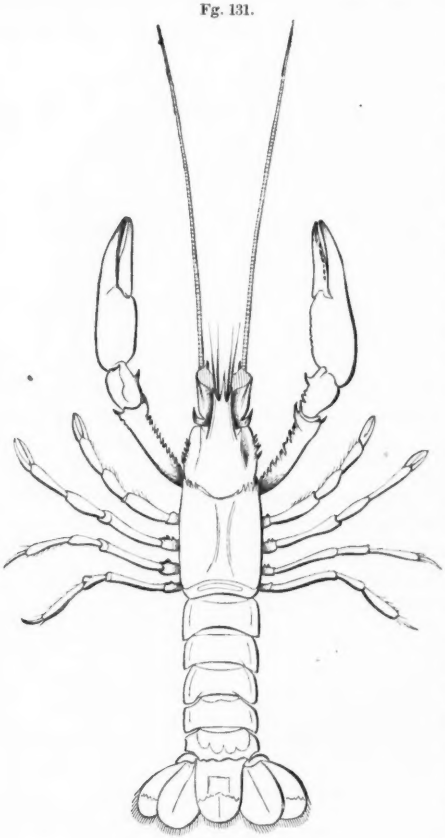
Spirostrephon Copei.

rarely seen by the dim light of a candle even after considerable search. Five specimens only were procured from about a dozen caves." The second species, *P. Vudii* Cope, was found in Montgomery Co. and he thinks it was not found in a cave. Professor Hyatt informs me that he saw near the "Bottomless Pit" in Mam-

moth Cave, a brownish centipede-like myriopod, over an inch in length, which moved off in a rapid zigzag motion. Unfortunately, he did not capture it.

Next to the blind fish, the blind crawfish attracts the attention of visitors to the cave. This is the *Cambarus pellucidus* (Fig. 131, from Hagen's monograph of the North American Astacidæ) first described by Dr. Tellkampf. He remarks that "the eyes are rudimentary in the adults, but are larger in the young." We might add that this is an evidence that the embryo develops like those of the other species; and that the inheritance of the blind condition is probably due to causes first acting on the adults and transmitted to their young, until the production of offspring that become blind becomes a habit. This is a partial proof at least that the characters separating the genera and species of animals are those inherited from adults, modified by their physical surroundings and adaptations to changing conditions of life, inducing certain alterations in parts which have been transmitted with more or

Fg. 131.



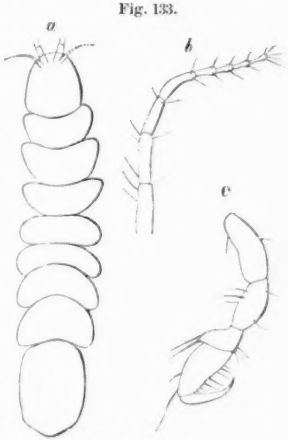
Cambarus pellucidus.

less rapidity, and become finally fixed and habitual. Prof. Hagen has seen a female of *Cambarus Bartonii* from Mammoth Cave, "with the eyes well developed," and a specimen was also found by Mr. Cooke. Prof. Hagen remarks that "*C. pellucidus* is the most aberrant species of the genus. The eyes are atrophied, smaller at the base, conical, instead of cylindrical and elongated, as in the other species. The cornea exists, but is small, circular, and not faceted; the optic fibres and the dark-colored pigments surrounding them in all other species are not developed." It seems difficult for one to imagine that our blind craw fish was created suddenly, without the intervention of secondary laws, for there are the eyes *more perfect in the young than the adult*, thus pointing back to ancestors unlike the species now existing. We can now understand, why embryologists are anxiously studying the embryology of animals to see what organs or characteristics are inherited, and what originate *de novo*, thus building up genealogies, and forming almost a new department of science: comparative embryology in its truest and widest sense.

Fig. 132.

Cwcidotea stygia (side view).

Fig. 133.



Cwcidotea stygia (dorsal view).

Of all the animals found in caves, either in this country or Europe, perhaps the most strange and unexpected is the little creature of which we now speak. It is an Isopod crustacean, of which the pill bugs or sow bugs are examples. A true species of pill bug (*Titanethes albus* Schiödte) inhabits the caves of Carniolia, and it is easy to believe that one of the numerous species of this group may have become isolated in these caves and modified into its present form. So also with the blind *Niphargus stygius* of Europe, allied to the fresh water Gammarus so abundant in pools of fresh water. We can also imagine how a species of Asellus, a fresh water Isopod, could represent the Idoteidæ in our

caves, and one may yet be found; but how the present form became a cave dweller is difficult of explanation, as its nearest allies are certain species of Idotea which are all marine, with the exception of two species: *I. entomon*, living in the sea and also in the depths of the Swedish lakes, as discovered by Loven, the distinguished Swedish naturalist, while a species representing this has been detected by Dr. Stimpson at the bottom of Lake Michigan. Our cave dweller is nearly allied to Idotea, but differs in being blind, and in other particulars, and may be called *Cæcidotea stygia.** (Fig. 132 side view, enlarged; Fig. 133 dorsal view; *b*, inner antenna; *c*, 1st leg.) It was found creeping over the fine sandy bottom, in company with the Campodea, in a shallow pool of water four or five miles from the mouth of the cave.

This closes our list of known articulates from this and other caves in this country, the result of slight explorations by a few individuals. The number will be doubtless increased by future research. It is to be hoped that our western naturalists will thoroughly explore all the sinks and holes in the cave country of the western and middle states. The subject is one of the highest interest in a zoological point of view, and from the light it throws on the doctrine of evolution. Professor Schiödte, the eminent Danish zoologist, has given us the most extended account of the cave fauna of Europe, which has been translated from the Danish into the Transactions of the Entomological Society of London (new series vol. 1, 1851).

He examined four caves; namely, that of Adelsberg, the Magdalena and Luege caves, all in the neighborhood of Adelsberg,

* Generic characters. Head large, much thicker than the body, and as long as broad; subcylindrical, rounded in front. No eyes. First antennæ slender, 8-jointed (2d antennæ broken off). Abdominal segments consolidated into one piece. Differs chiefly from Idotea, to which it is otherwise closely allied, by the 8-jointed (instead of 4-jointed) 1st (inner) antennæ, the very large head, and by the absence of any traces of the three basal segments of the abdomen usually present in Idotea.

Specific characters. Body smooth, pure white: tegument thin, the viscera appearing through. Head as wide as succeeding segment, and a little more than twice as long. Inner antennæ minute, slender, the four basal joints of nearly equal length, though the fourth is a little smaller than the basal three, remaining four joints much smaller than others, being one-half as thick and two-thirds as long as either of the four basal joints; ends of last four joints a little swollen, giving rise to two or three hairs; terminal joint ending in a more distinct knob, and bearing five hairs. Segment of thorax very distinct, sutures deeply incised; edges of segments pilose; abdomen flat above, rounded behind, with a very slight median projection; the entire pair of gills do not reach to the end of the abdomen, and the inner edges diverge posteriorly. Legs long and slender, 1st pair shorter, but no smaller than the second. Length .25 inch.

and the Corneale cave at Trieste. The only plant found was a sort of fungus, *Byssus fulvus* Linn. The only vertebrate is the singular salamander, *Hypochthon* (Proteus) *anguinus*, found in the Magdalina river. No shells were found. Regarding the articulates he writes:

"On searching along the walls within the entrance of the caves, among the rubbish and the vegetable debris along the sides of the river, we meet with a considerable number of Insecta, Myriopoda, Arachnida and Crustacea, of various families which shun daylight; being such species only as inhabit promiscuously other places, provided they are moist and feebly illumined. We find species of Pterostichus, Pristonychus, Amara, Quedius, Homalota, Omalium, Hister, Trichopteryx, Cryptophagus, Atomaria, Ptinus, Ceraphron, Belyta, a grasshopper of the Locust family, probably the *Raphidophora cavicola* Fischer, as it was only seen in the larva state, Trichoptera, Sciara, Psychoda, Phora, Heteromyza, Sapromyza, Tomocerus, Linyphia, Gamasus, Cryptops, Julus, and Asellus. In proportion as we recede from the entrance the number of species as well as individuals greatly decreases, and at the distance which entirely excludes the light, only single individuals are found. In the deepest recesses these species are entirely wanting, except some few which have been transported by the current; only a few Diptera are found; namely, a species of Phora, very near *P. maculata* Meig., *Heteromyza flavipes* Zett., and *Sapromyza chrysophthalma* Zett., extending also very far into the caves, even to the remotest accessible places in Adelsberg cave, more than half an hour's walk from its entrance. Dead moths are occasionally found far in the caves, being left there by the bats; and likewise accidental specimens of the parasites of the latter. Of the five earlier known animals which inhabit these caves, I found *Pristonycha elegans* Dej. rather frequently, and *Homalota spelæa* Er. in considerable numbers. Besides these are *Anopthalmus Schmidtii*, which is very rare, and the wood louse, *Titanethes alba*. The new forms he found were a beetle (*Bathyscia byssina*) allied to our Adelops;* *Stagobius troglodytes*, an aberrant genus of Silphids; a Podurid, *Anurophorus Stillicidii;* and the two blind arachnidans, one a spider allied to Dysdera, the *Stalita tænaria*, and a false-spider, *Blothrus spelæus*. Among the crustacea he found *Niphargus stygius*,†

* Ludwig Müller enumerates four other species of Adelops from these caves, and three species from France, and *Machærites spelæus*, in Verhandl. Zool. Bot. Vereins, Wien, 1855, p. 505. See also Heller's Beitrage zur österreich. Grotten-Fauna. (Myriopoda and Crustacea.) Vienna, 1858. He describes a myriopod with rudimentary eyes (*Trachysphæria Schmidtii*) allied to Glomeris, and another blind species (*Brachydesmus subterraneus*) allied to Polydesmus; also a new *Tithanethes* (*T. graniger*), and notices *Monolistra cæca* Gerst. Wankel (1861) also found a new Phalangid (*Leiobunum troglodytes*) with distinct eyes and four species of mites in the caves of Eastern Austria. The mites are *Scyphius spelæus*, *Linopodes subterraneus*, *Gamasus loricatus* and *G. niveus*, and an additional species of Trachysphæria (*T. Hyrtlii*). See also Ehrenberg's list of cave insects (Monabsberichte der Akad. Berlin. 1861.)

† Several species of Niphargus occur in the wells and hot springs in Europe. Accord-

allied to Gammarus, which lives in small pools of water and is white and blind; and the cave pill bug, *Titanethes albus* (Koch.)."

In conclusion Schiödte remarks that:—

"We may with propriety apply the collective term *Subterranean Fauna* to those animals which exclusively inhabit caves, and are expressly constructed for such habitations. Still there is nothing in this name which would indicate that these animals have any claim to be considered as a separate group, beyond the mere peculiarity of their common place of abode. While a few of them possess such an extraordinary structure as to stand in no comparison with those animals which inhabit the light, there are others, forming only more characteristic links in the groups of animals more or less shy of light, of which many are found common in the localities of the caves; and some belong to genera having a wide local, as well as geographical, extension. We are accordingly prevented from considering the entire phenomenon in any other light than something purely local, and the similarity which is exhibited in a few forms (Anophthalmus, Adelops, Bathyscia) between the Mammoth Cave and the caves in Carniola, otherwise than as a very plain expression of that analogy, which subsists generally between the fauna of Europe and of North America. Besides, it is clear to me that the fauna of the caves of Carniola consists of two divisions, of which the essential character is referable on the one hand to the dark locality, and on the other to the additional confinement to stalactitic formations; as yet we are not

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ing to Bate and Westwood (British Sessile eyed Crustacea) "the British examples have been obtained from artificially excavated wells connected with houses for domestic purposes. In some instances the wells have been old, in others but recently dug. In their geological condition the habitats have been equally various. At Corsham the well exists in the Oolite formation, at Ringwood in chalk-flint gravel, at Mannamead in slate. At Corsham and Mannamead they are found on a hill, at Ringwood they lie low. The appearance of some of these animals in a well soon after its being excavated, raises a question of considerable interest. Thus they were found at upper Clafford, near Andover and at Mannamead, near Plymouth, but not a trace of them was to be found in the surrounding streams; in fact they perish in the light. It is impossible to regard them as an extreme variety, or modification of our only fresh water Amphipod, *Gammarus fluviatilus*, since various parts not only differ in form, but some are altered in character; for example, the extraordinary elongation and slenderness of one of the branches of each of the last pair of caudal appendages seem to be a special structure, having for its object the antenna-like use of a delicate apparatus at the extremity of the body. . . . . Although we can find no fresh water ally to this genus in the rivers and streams of Europe, yet Bruzelius has taken in the deep sea, near Bohusia, a form which he has described under the name *Eriopis elongata*, approximating so nearly to it that it appears to be scarcely generically distinct.

We are inclined to think that *Gammarus pungens* of Milne Edwards, from the warm springs of Cassini in Italy, also belongs to this genus." Of Niphargus these are the following species known besides *N. stygius*; *i.e. N. aquilex* Schiödte (*Gammarus puteanus* Koch, the embryology of which has been studied by V. St. George) *N. fontanus* Bate, *N. Kochianus* Bate. Another generic form is *Crangonyx* founded by Bate, which also belongs to the subterranean fauna. "A single species as yet is all that has been found in England; but we have little doubt but that *Gammarus Ermanni* of Milne Edwards which was found by M. Ermann in the warm springs of Kamtschatka belongs also to this genus. It is curious that we should have to record that while the animals of this genus, as in the preceding (Niphargus) inhabit the deep artificial wells, without being known to exist in our rivers and streams, its nearest allied form is to be found in a marine genus, Gammarella."

able vigorously to discriminate between the two. We shall accordingly look upon the subterranean fauna, or more properly faunas, as small ramifications which have penetrated into the earth from the geographically-limited faunas of the adjacent regions; and which, as they extended themselves into darkness, have been accommodated to surrounding circumstances. Animals not far remote from the ordinary forms, prepare the transition from light to darkness. Next follow those that are constructed for twilight; and last of all those destined for total darkness, and whose structure is quite peculiar. Among these some are adapted for special localities, those which inhabit dry localities or detached little reservoirs being totally blind, while others, destined for running streams, have eyes of imperfect construction, so as to receive the impression of rays of light, but no proper image of illuminated objects. We may therefore with tolerable precision arrange the inhabitants of caverns under the following heads:—

Shade animals.—Extensive genera and species inhabiting caverns near their entrance, and, generally, all cool, shady and moist localities. Of these, those that fly occasionally enter far into the caverns (Diptera).

Twilight animals.—They belong to widely spread genera, but are peculiar to the caves, and distinguished by their small eyes. They are principally found near the entrances to the caves, but proceed deeper into the darkness than the shade-animals, and although wingless, they penetrate often the whole extent of the dark space.—(*Pristonychus elegans, Homalota spelwa.*)

Cave animals.—They form, at least in part, peculiar genera, are wingless and colorless, as far as the consistency of their integuments will admit, and exist exclusively in total darkness. The terrestrial division is blind; the aquatic has a perception of light. To this group belong all the animals in the Mammoth Cave, and among those of the caves of Carniola, Anophthalmus, Bathyscia, perhaps likewise Anurophorus and Hypochthon, which, however, may belong to the following group.

Stalactite cave animals.—Insects, Arachnidans and Crustaceans appertaining to peculiar genera, wingless, blind, brightly colored according to the nature of their integuments, either light brown, yellowish white, or snow white, perhaps according to the preponderance of the chitine; living in total darkness, peculiar to stalactite caves, in part occupying the columns and constructed accordingly, either for ascent or hovering over them. Here belong most of the animals treated of in this memoir—Stagobius, Blothrus, Stalita, Niphargus, and Titanethes."*

A pertinent question arises as to the time of the formation of these caves and when they became inhabitable. As previously stat-

*In a note appended he adds to the list "a new cave crustacean, *Palomon anopthalmus* Kollar, said to serve as food for Hypochthon [the Salamander], of which last genus he discriminates six species."

ed, the caves of the western and middle States are in lower Carboniferous limestone rocks, though the Port Kennedy cave explored by Wheatley and Cope† is in the Potsdam limestone. They could not have been formed under water, but when the land was drained by large rivers. This could not have occurred previous to the Triassic period. Prof. Dana in his "Manual of Geology" shows that the Triassic continent spread westward from the Atlantic coast "to Kansas, and southward to Alabama; for through this great area there are no rocks more recent than the Palæozoic." "Through the Mesozoic period [comprising the Triassic, Jurassic, and Cretaceous periods] North America was in general dry land, and on the east it stood a large part of the time above its present level." Though at the close of these periods there was a general extinction of life, yet this was not probably a sudden (one of months and even years), but rather a secular extinction, and there may be plants and animals now living on dry land, which are the lineal descendants of mesozoic and more remotely of Carboniferous forms of life. So our cave animals may possibly be the survivors of Mesozoic forms of life, just as we find now living at great depths in the sea remnants of Cretaceous life. But from the recent explorations in the caves of Europe and this country, especially the Port Kennedy cave, with its remarkable assemblage of vertebrates and insects, we are led to believe from the array of facts presented by Prof. Cope that our true subterranean fauna probably does not date farther back than the beginning of the Quaternary, or Post pliocene, period. We quote his "general observations" in his article on the Port Kennedy fauna.

"The origin of the caves which so abound in the limestones of the Alleghany and Mississippi valley regions, is a subject of much interest. Their galleries measure many thousands of miles, and their number is legion. The writer has examined twenty-five, in more or less detail, in Virginia and Tennessee, and can add his testimony to the belief that they have been formed by currents of running water. They generally extend in a direction parallel to the strike of the strata, and have their greatest diameter in the direction of the dip. Their depth is determined in some measure by the softness of the stratum, whose removal has given them existence, but in thinly stratified or soft material, the roofs or large

†A notice of the animals found in this cave will be found in the Proceedings of the American Philosophical Society, April, 1871. The insects there enumerated would probably not come under the head of cave insects.

masses of rocks fall in, which interrupt the passage below. Caves, however, exist when the strata are horizontal. Their course is changed by joints or faults, into which the excavating waters have found their way.

That these caves were formed prior to the postpliocene fauna is evident from the fact that they contain its remains. That they were not in existence prior to the drift is probable, from the fact that they contain no remains of life of any earlier period so far as known, though in only two cases, in Virginia and Pennsylvania, have they been examined to the bottom. No agency is at hand to account for their excavation, comparable in potency and efficiency to the floods supposed to have marked the close of the glacial period, and which Prof. Dana ascribes to the Champlain epoch. An extraordinary number of rapidly flowing waters must have operated over a great part of the Southern States, some of them at an elevation of fifteen hundred feet and over (perhaps two thousand) above the present level of the sea. A cave in the Gap Mountain, on the Kanawha river, which I explored for three miles, has at least that elevation.

That a territory experiencing such conditions was suitable for the occupation of such a fauna as the deposits contained in these caves reveal, is not probable. The material in which the bones occur in the south is an impure limestone, being mixed with and colored by the red soil which covers the surface of the ground. It is rather soft but hardens on exposure to the air.

The question then remains so far unanswered as to whether a submergence occurred subsequent to the development of the postpliocene mammalian fauna. That some important change took place is rendered probable by the fact, that nearly all the neotropical types of the animals have been banished from our territory, and the greater part of the species of all types have become extinct. Two facts have come under my observation which indicate a subsequent submergence. A series of caves or portions of a single cave once existing on the southeast side of a range of low hills among the Alleghany mountains in Wythe Co., Virginia, was found to have been removed by denudation, fragments of the bottom deposit only remaining in fissures and concavities, separated by various intervals from each other. These fragments yielded the remains of twenty species of postpliocene mammalia.* This denudation can be ascribed to local causes, following a subsidence of uncertain extent. In a cave examined in Tennessee the ossiferous deposit was in part attached to the *roof* of the chamber. Identical fossils were taken from the floor. This might, however, be accounted for on local grounds. The islands of the eastern part of the West Indies appear to have been separated by submergence of larger areas, at the close of the period during which they

*See Proceed. Amer. Phil. Soc. 1869, 171.

were inhabited by postpliocene mammalia and shells. The caves of Anguilla include remains of twelve vertebrates,* of which seven are mammalia of extinct species, and several of them are of large size. These are associated with two recent species of molluscs *Turbo pica*, and a *Tudora* rear *pupæformis*.† As these large animals no doubt required a more extended territory for their support than that represented by the small island Anguilla, there is every probability that the separation of these islands took place at a late period of time and probably subsequent to the spread of the postpliocene fauna over North America."

I think the reader will conclude from the facts Prof. Cope so clearly presents, that the subterranean fauna of this country does not date back of the Quaternary period. These species must have been created and taken up their abode in these caves (Mammoth Cave and those of Montgomery County, Virginia) after the breccia flooring their bottoms and containing the bones of Quaternary animals had been deposited; or else migrated from Tertiary caves farther south, which is not probable, as it has been previously shown that those blind animals inhabiting wells immediately die on being exposed to the light. (British Sessile-eyed Crustacea, i, p. 313.)

The case becomes much simpler when we consider the age of the rocks in which the Adelsberg and other caves mentioned by Schiödte are situated. The Alps were under water in the Middle Eocene; consequently the caves could not have been formed until the close of the Tertiary. Hence the species of the cave fauna were evidently created either at the close of the Tertiary, or more probably the beginning of the Quaternary, as "even in the later part of the Pliocene era there was an elevation of three thousand feet in a part of the Island of Sicily" (Dana). We are therefore led to conclude that the species of the subterranean fauna the world over are recent creations, probably not older than the extinct mammals associated with man.

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*Loc. cit. 1869, 183; 1870, 608. A fourth species of gigantic Chinchillid has been found by Dr. Rijgersma, which may be called *Loxomylus quadrans* Cope. It is represented by portions of jaws and teeth of three individuals. It is one of the largest species, equalling the *L. latidens*, and has several marked characters. Thus the roots of the molars are very short, and the triturating surface oblique to the shaft. The roots of the second and fourth are longer than those of the first and third. The last molar has four dental columns instead of three as in the other *Loxomyli*, and is triangular or quadrant-shaped in section; the third is quadrangular in section, and has three columns. The second is the smallest, being only .6 the length of the subtriangular, first. Length of dental series m. .063 or 2.5 inches. Palate narrow and deeply concave. There is but little or no lateral constriction in the outlines of the teeth; the shanks are entirely straight. In its additional dentinal column, this species approaches the genus *Amblyrhiza*.

The large Chinchillas of Anguilla are as follows, *Loxomylus longidens*, *L. latidens*, *L. quadrans*, and *Amblyrhiza inundata*.

†See Bland, Proceed. Amer. Phil. Soc., 1871, 58.

Assuming on the principles of evolution that the cave animals were derived from other species changed by migration from the outer world to the new and strange regions of total darkness, it seems evident that geologically speaking the species were *suddenly* formed, though the changes may not have been wrought until after several thousand generations. According to the doctrine of natural selection, by which animal species pass from one into another by a great number of minute variations, this time was not sufficient for the production of even a species, to say nothing of a genus. But the comparatively sudden creation of these cave animals affords, it seems to us, a very strong argument for the theory of Cope and Hyatt of creation by acceleration and retardation, which has been fully set forth in this journal. The strongly marked characters which separate these animals from their allies in the sunlight, are just those fitting them for their cave life and those which we would imagine would be the first to be acquired by them on being removed from their normal habitat.

On introducing the wingless locust, *Rhaphidophora maculata*, into a cave, where it must live not under stones, but by clinging to the walls, its legs would tend to grow longer, its antennæ and palpi would elongate and become more delicate organs of hearing as well as touch,* and the body would bleach partially out, as we find to be the case in *R. subterranea* and *stygia*. The Carabid beetle, Anopthalmus, extending farther into the cave, would lose its wings (all cave insects except the Diptera have no wings, elytra excepted) and eyes, but as nearly all the family are retiring in their habits, the species hiding under stones, its form would not undergo farther striking modification. So with the blind Campodea, which does not differ from its blind congeners, which live more or less in the twilight, except in its antennæ becoming longer. The blind Adelops; but with rudiments of eyes, does not greatly depart in habits from Catops, while on the other hand the remarkable Stagobius of the Illyrian caves, which according to

* After writing this article, and without knowledge of his views, we turned to Darwin's Origin of Species to learn what he had to say on the origin of cave animals. He attributes their loss of sight to disuse, and remarks:—"By the time an animal has reached, after numberless generations, the deepest recesses, disuse will on this view have more or less perfectly obliterated its eyes, and natural selection will often have effected other changes, such as an increase in the length of the antennæ or palpi, as a compensation for blindness." 5th Amer. Edit., p. 143. We are glad to find our views as to the increase in the length of the antennæ and palpi compensating for the loss of eyesight, confirmed by Mr. Darwin.

Schiödte spends its life in crawling ten to twenty feet above the floor over the columns formed by the stalactites, to which unique mode of life it is throughout perfectly adapted, is remarkably different from other Silphids. Its legs are very long and inserted far apart (the prothorax being remarkably long), with surprisingly long claws, while the antennæ, again, are of great length and densely clothed with hairs, making them most delicate sense organs.* So also are the limbs of the false scorpion, and the spider and pill bug (Titanethes) of remarkable length.

But the modifications in the body of the Spirostrephon are such that many might deem its aberrant characters as of generic importance. It loses its eyes, which its nearest allies in other, but smaller, caves possess, and instead gains in the delicate hairs on its back, which evidently form tactile organs of great delicacy; the feet are remarkably long, as also the antennæ. These are not new formations but simply modifications apparently, by use or disuse of organs present in the other species. The aberrant myriopod and Stagobius are paralleled by the blind fish, an animal so difficult to classify, and so evidently adapted for its abode in endless darkness. And as an additional proof of the view here taken that these cave animals are modified from more or less allied species existing outside of the caves, we have the case of the craw fish, whose eyes (like those of the mole), are larger in the young than adult, indicating its descent from a species endowed with the faculty of sight, while in the adult the appendages are modified as tactile organs so as to make up for its loss of eyesight, in order that it may still take its prey.

We thus see that these cave animals are modified in various ways, some being blind, others very hairy, others with long appendages. All are not modified in the same way in homologous organs; another argument in proof of their descent from ancestors

*Schiödte remarks that "it is difficult to understand the mode of life of *Stagobius troglodytes;* or how this slow and defenceless animal can escape being devoured by the rapid, piratical Arachnidans, or find adequate support on columns, for inhabiting which it is so manifestly constructed. We are led in this respect to consider the antennæ. Whatever significance we attach to those enigmatical organs, we must admit that they are organs of sense, in which view an animal having them so much developed as Stagobius, must possess a great advantage over its enemies, if these be only Arachnidans. Its cautious and slow progress, and its timid reconnoitring demeanor, fully indicate that it is conscious of life being in perpetual danger, and that it endeavors to the utmost to avoid that danger. Darkness, which always favors the pursued more than the pursuer, comes to its aid, especially on the uneven excavated surface of the columns."

whose habits varied as their out-of-door allies do at present. Had they been specially created for subterranean life, we should have expected a much greater uniformity in the organs adapting them to a cave life than we actually find to be the case.

Another fact of interest in this connection is the circumstance that these cave species breed slowly, being remarkably poor in individuals; they are nearly all extremely rare. Did they breed as numerously as their allies in the outer world the whole race would probably starve, as the supply of food even for those which do live is wonderfully limited.

It is now known that animals inhabiting the abysses of the sea are often highly colored: light must penetrate there, for we know that were the darkness total they would be colorless like the cave insects.

In view of the many important questions which arise in relation to cave animals, and which have been too imperfectly discussed here, we trust naturalists the world over will be led to explore caves with new zeal, and record their discoveries with minuteness, and the greatest possible regard to exactness. The caves of the West Indian Islands should first of all be carefully explored. Also those of Brazil, those of the East Indies, and of Africa, while fresh and most extended explorations of our own Mammoth Cave should be made, perhaps by a commission acting under government or State authority, in order that the most ample facilities may be afforded by the parties owning the cave.

A SINGING HESPEROMYS.

BY REV. SAMUEL LOCKWOOD, PH. D.

Some twenty years ago, it was, that the "London Charivari" shot its shafts of ridicule at a singing mouse on exhibition in the metropolis. Thus put upon the scent, the firm of Pooh, Pshaw & Co., whose merciless power is alike feared by philosopher and peasant, "went for" the showman and his "phenomenon."

> And so hard was the *punch*-ing,
> And such was the fuss,
> That it quite put an end
> To that musical *mus!*

Albeit the miserable end of poor *Mus musculus*, we are bold to declare our knowledge of the existence of singing mice of the above domestic sort; and farther, our belief that they are not very uncommon. But we now propose to introduce to the readers of the NATURALIST an aristocratic, and entirely new candidate for their consideration—a musical wood-mouse.

Last spring, my friend Philip Ryall, Esq., brought from Florida a mouse which he had captured in his residence there. He says that for a number of nights, a low sound of a more or less musical nature, had been heard proceeding, as was supposed, from the chimney, and which very naturally was attributed to the chimney swallow. One day a small mouse came from under the hearth into the middle of the floor of the sitting-room, sat up, and sang for about a minute, and retired. This explained the mystery. Its nightly music and its daily visit were continued, almost invariably, the visit being limited to the same small area of the floor. It was determined to capture the little stranger; which after many unsuccessful efforts was finally accomplished. Last June the interesting little fellow was very kindly passed into my custody. My first concern was to add to its comfort by enlarging its cage, also to provide for it in every possible way a condition of things suited to its nature. For all this I was amply rewarded in the fine health, and the musical performances that followed.

A little study soon determined that the pretty creature belonged to the vesper mice. It is known by the popular names of jumping mouse, wood mouse, and white-footed mouse. Our specimen is one of the smallest of its own genus, for the precise species is the one known to naturalists as the *Hesperomys cognatus* Leconte. This fact, so novel, once determined, gave additional zest to my purpose to make it the object of especial study. To give it individuality, as it was fast becoming a pet, I named it Hespie; which name, as its object was a female, was certainly appropriate. I thought she soon learned to know me, and certainly I soon came to regard her with attachment. Yet, the truth told, she was a pretty, pert and unamiable little miss, and would permit no familiarity, always biting the finger that attempted to touch her. Her animation, agility and gracefulness of motion were wonderful. Sometimes a fly would enter the cage, when she would spring at, and catch it, sometimes with her mouth, and at others with her hands. This she would eat with great relish. So uniformly quick were her motions, that on

one occasion my little boy said: "Papa, I would like to see mousie *walk* just once." Her taste was quite omnivorous; although unlike the domestic mouse, she did not care much for cheese. But meat, bread, corn, nuts, sugar, and even pudding and fish were all acceptable. A little sod of fresh grass and white clover was occasionally put into the cage. This she enjoyed greatly, eating the greens like a rabbit; only always insisting on sitting up to do it. It was interesting to witness how ready she was for emergencies. Sitting on her hind feet, she would take hold with her hands of a blade of grass, and begin eating at the tip. The spear would rapidly shorten, and seemingly she must now stoop to finish it, or do it in the ordinary quadrupedal style. Now that was just what she did not choose to do. So when the emergency came, she would stoop down, and in a trice cut the blade off close to the sod with just one nip; then up again on her feet in a sitting posture, she would finish it in a comfortable and becoming way. On one occasion a worm crept out of the sod, and Hespie at once fell to it and soon had it tucked away without cooking. As to exercise, she manages to take a great deal. In the day time her exercise is less, as she does a good deal of sleeping then. It is at night that her peculiar talents appear to advantage, beginning at vespers, as her name might imply. Then, as a singer, her genius literally shines. It is with her singing that we are the most concerned; and indeed, at the moment of this writing (for it is night) she is in fine song. Perhaps, however, it will seem more literal and actual if her performances are described in the past tense.

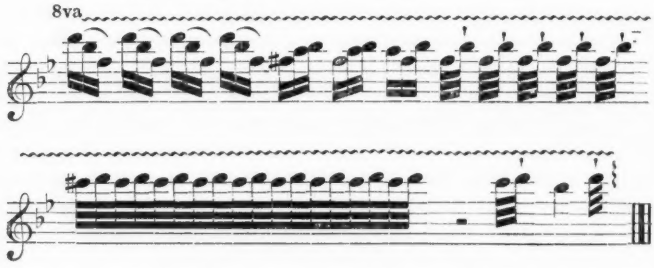
Our little musician had several snatches or bits of melody which were often repeated. But in her *repertoire* were two notable ones, each of which deserves to be dignified as a professional *role*. The one by far the more frequent is notated below; and because it is her favorite, when running in her revolving cage, I have named it *The Wheel Song*.*

The last bar of this would frequently be prolonged to two or three; and she would sometimes change from C sharp and D, to C natural and D, then warble on these two notes awhile, and wind up with a quick chirp on C sharp and D. The distinctness between the semitones was very marked, and easily appreciable to a good ear. I have always enjoyed the mellow little strains of the song sparrow and the house wren. But in either case it was short, and

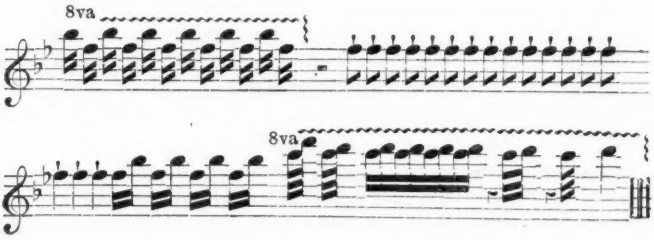
*The musical notation was written by my son, Ferris C. Lockwood.

apt to become monotonous from its admitting almost no variation. Monotony was not chargeable to Hespie's Wheel Song. With unconscious skill she would work out of it a wonderful variety. Instead of the first measure she would sometimes open with the second one, then follow it with the first. Or she might start with the third, following with the second, or the first, just as fancy seemed to dictate. Then she had her own whims as to the amount of repetition of each bar; that is to say, she would double or even

NO. 1. THE WHEEL SONG.



NO. 2. THE GRAND ROLE.



triplicate a measure, when the notion took her. In this regard, time was quite ignored. Indeed, whatever may have been the Hesperomys' canon of musical procedure or propriety, we could not but regard it as arbitrary, or beyond our comprehension. Still it must be admitted, that this little performer possessed precision, delicacy, and scope of execution.

She had one role, which although the notation is simpler than that of the Wheel Song, yet I think to her its execution was more

difficult. It is certain that she was far more chary of its performance; and to me its effect seemed more impressive. I have on account of its less frequency distinguished it as *The Grand Role*.

This was seldom given, yet quite often enough to allow it to be written down. The second measure would be sung quite fast, sounding almost like the pecking of the woodpecker on the tree; and at other times it would be slow like the dropping of water. Although she had no ear for time, yet she would keep to the key of B (two flats), and strictly in a Major key. This fact I considered interesting, as Wood declares his belief "that the untaught cries of all the lower animals, whether quadrupeds or birds, are in the Minor key." Herein theory must yield to observation. If I might venture an opinion, it would be that the music of the really musical wild animals is oftener on a Major key; while the Minor key characterizes savage man. A remarkable fact in the above *role* is the scope of little Hespie's musical powers. Her soft, clear voice falls an octave with all the precision possible; then at the wind-up, it rises again into a very quick trill on C sharp and D.

Though it be at the risk of taxing belief, yet I must in duty record one of Hespie's most remarkable performances. She was gambolling in the large compartment of her cage, in a mood indicating intense animal enjoyment, having woke from a long sleep, and partaken of some favorite food. She burst into a fulness of song very rich in its variety. While running and jumping, she rolled off what I have called her Grand Role, then sitting, she went over it again, ringing out the strangest diversity of changes, by an almost whimsical transposition of the bars; then without for an instant stopping the music, she leapt into the wheel, started it revolving at its highest speed, and went through the Wheel Song in exquisite style, giving several repetitions of it. After this she returned to the large compartment, took up again the Grand Role, and put into it some variations of execution which astonished me. One measure I remember was so silvery and soft, that I said to a lady who was listening, that a canary able to execute that would be worth a hundred dollars. I occasionally detected what I am utterly unable to explain, a literal dual sound, very like a boy whistling as he draws a stick along the pickets of a fence. So the music went on, as I listened, watch in hand, until actually *nine minutes had elapsed*. Now the wonderful fact is that the res between the roles was never much more than for a second of time;

and during all this singing the muscles could be seen in vigorous action through the entire length of the abdomen. This feat would be impossible to a professional singer; and the nearest to it that I have seen was the singing of a wild mocking bird in a grove.

For several days the wheel grated on its axle. This afforded Hespie great delight; and her own little warble was completely lost in the harsher sound. It was pretty much as it is with some of the modern methods of praise; as when the vocal is subordinated to the instrumental, a mere murmur of song, on which the organist comes down as with the sound of many waters. A drop of oil, and the sound of the friction stopped. This quite excited her temper; and she bit the wires of her wheel most viciously. A little device was hit upon which set her in good humor again. A strip of stout writing paper, a half inch wide, was pinned down in such a way that its clean cut upper edge pressed against the wires of the wheel, making with its revolution a pleasant, purring sound. It was on the principle, exactly, of the old-time watchman's rattle, and the old toy known as a cricket. This for a while greatly delighted the capricious creature, and she made the wheel almost fly; at the same time, in unison with the whirr of the wheel, was her own soft, cheery warble. It was very low, yet very distinct. I remember once on a larger scale witnessing an analogous sight, when, unseen, I entered a room in which was a woman spinning wool, and singing at the top of her voice, in keeping with the loud whirring of her spinning wheel. Without her wheel the domestic life of little Hespie would be rather monotonous. Expecting to see some antics in the slipping line, the trick was tried of covering a part of the inside of the wheel with smooth sized paper. Mousie entered and started the wheel, and in the prettiest way jumped the smooth paper floor at every revolution, actually keeping the propulsion up with but a slight diminution of the usual speed. This was certainly a very pretty feat. We next shut her out by corking up the entrance. She worked desperately at the closed aperture; then in despair gave vent to a piercing little cry. It was surprising what a strange pleasure this sound afforded me; it showed so clearly the difference in the timbre or quality of this sound of distress from that which I have called its singing. She was a good deal excited, and ran frantically into and out of her little bed-box, which had a hole at each end. Soon this tiny gust of rage passed over. She

now, although running about her cage, indulging in little gambols, indicating exquisite grace and agility, struck off into a truly beautiful strain of song. It occupied about three minutes, and had in it considerable scope and variety. First there was a clearly enunciated expression like that of the cooing of a turtle dove, a soft note, with a deliberate slowness. This changed into a series of more rapid notes strangely suggesting, though not so weird-like, the conchy clamor of the American cuckoo (*Coccyzus*), then closing with a series of short, rapid sounds, like the tapping of the woodpecker on a tree.

A very noticeable fact was, that a great deal of this little creature's song was poured forth while at play — that is, while in actual activity; and, take the wheel-play, for instance, when really in quite violent exercise. A thing, too, which much surprised me, was, that often when eating she sang and ate at the same time, literally in the same breath. This singular habit, so suggestive of a great physiological difficulty, led to an incident, which caused considerable merriment for those who witnessed it. I had been examining some insect larvæ on a twig of black alder. Without any real motive, a bit of the twig, about an inch long, and an eighth of an inch thick, was offered to Hespie. She was delighted, and at once began in her usual pretty way, sitting up, to eat the bark, although it is very bitter. Thus she sat "bolt upright;" and the manner in which she held this little black stick in both hands up to her mouth, at the precise angle in which a fife is held, although nibbling away, yet singing at the same time, it looked so like a little fifer playing on an ebony fife that laughter was irresistible at the comical sight.

Wishing to see how this Hesperomys would behave in company, I put into her cage a young domestic mouse about one-third grown. She was asleep in her little box. When she woke, it was a pretty sight. What animation! How the black eyes started and sparkled! To me they seemed to snap with fire. The whole frame was in a quiver — first of astonishment, then with rage. It was not a run — but a jump which she made at the little involuntary intruder, who received a nip that made it squeal in terror. We removed the little captive, who was so astonished that it was quite content to lie in our hand. Its terror had won our pity, and we restored to it its liberty. I had a friend who had once a singing domestic mouse, of very moderate musical ability, however. But

one day he captured two specimens of the white-footed mouse (*Hesperomys leucopus*), and supposing it would be good company, he put them into the cage. Great mistake it was. The two white-footed barbarians abused the hospitality, and murdered poor *Mus musculus*.

And now we ask are these phenomena that have been herein described the result of an abnormal condition of things or not? How much truth is there in the theory of some that the singing of these mice is the result of disease, or of some bronchial disturbance? In my opinion the following reasons disprove the truth of any such theory.

1. The exquisite animal enjoyment, and actual physical condition, for it is fat, and perfect in pelage and form, indicating high health. Every form of bronchial disease is in its most ordinary effect depressing to the animal spirits.

2. When engaged in song, the exercise reaches to the very depth of the chest, as is so often seen in the lowing of kine, where the muscles may be observed in action for the whole length of the abdomen. Persons afflicted bronchially avoid deep vocal exercises.

3. The singing is so often performed under those precise circumstances in which bronchially diseased persons are sure to keep still, if possible. For instance, take the Wheel Song. Here, although the exercise was violent, yet the song would be sustained all through with no diminution of vocal strength; and quite frequently was it the case, that when the animal stopped turning the wheel, though it continued the song, the momentum would throw it on its back, when as if in surprise, it would roll off four or five notes on a higher octave, and in a greatly increased loudness of voice.

4. Our vesper mouse delights in a role, the performance of which argues these three facts: — A high organization of the organs of the voice; delicate and skilful adjustment during use; a perfect condition as respects health. She can sing and eat at the same time. When a boy the writer was fond of whistling, usually selecting some ballad tune; and it was with perfect ease that the strain was continued through an entire stanza, without any break for the sake of getting breath; for ere the expiring air had become exhausted, he inverted the process, thus continuing his strain by the inspiring air as it came through the orifice formed by his lips. He also remembers that it was said of Jenny Lind that she could

use the inspiring breath in singing, though he cannot vouch for the fact. Now this fact, in the case of our Hesperomys, that it could eat and sing at the same time, even admitting, what is probably true, that there are intervals of a very short duration (so short as to be almost undiscernible) when the epiglottis closes to allow the food to pass down the gullet, demonstrates, as we think, that the organization of those parts was very delicate, and that the whole organism was in the very highest condition of health. We say nothing about that dual vocalization, other than that we think it looks in the same direction.

Probably it may occur to some that the pathology could be better demonstrated by dissection. To us it hardly seems that such a proof is needed. But I confess to a desire for all possible knowledge from such a source as respects certain physiological questions which I feel impelled to propose. In the human ear is a stringed instrument of amazing delicacy. The physiologist calls it the Fibres of Corti. It is wonderfully suggestive of the strings and keys of a piano; and it is believed that it ministers to the musical function. Query: has our little musician this mysterious organ? If so, in how much is it like that possessed by man? And as Hespie lacked time in her music, and as all animals, other than man, lack harmony, is this delicate organ consonant with that defect? Alas! we may not bring to this matter, though under our hands and our eyes, processes of investigation so delicate as the astronomer applies to matter far distant in space.

We would not run into the vice of generalizing on too scanty a stock of facts. Yet we are disposed to think that as an order the rodents possess a large amount of undeveloped ability for musical utterance. Few of us are aware to what extent among the domestic mice singers abound. Singing rats also have been observed. We have now the Hesperomys, thus affording three well marked genera of the Muridæ. Of the Sciuridæ, or squirrels, I can only speak of three genera with certain knowledge — the gray squirrel, the chipmunk, and the flying squirrel. All these are capable of musical sounds, though not to be called singers. And there is also the whistling of the woodchuck in its burrow. Last summer I caught a young rabbit in a patch of wild lupines, and was struck with the silvery musical ring of its cry, when my hand touched it. It is worth asking how far man's training or culture could develop and improve this potentiality or latent power in the rodents to

sing. My friend, who caught the object of this article, is firm in the belief that on one occasion it made, not without some success, an effort to imitate the canary. If this is a fact, it would of itself prove much in the direction of these remarks.

THE LONG-CRESTED JAY.

BY ELLIOTT COUES.

THIS bird is the *Cyanura macrolopha* of naturalists, and the genus it belongs to is distinguished among our jays by the ele-

Fig. 134.

The Long-crested Jay.

gant crest that all the species possess, as well as by the rich blue color that shows particularly on the wings and tail, which are also barred with black. This group of birds will be immediately recognized, when we say that the familiar blue jay of the eastern United States is the type of the whole; there are only half a dozen species, among which the common eastern species stands a little apart, being ornamented with richer and more variegated colors, and inhabiting a different zoological province. In the west it is represented by two kinds, Steller's and the Long-crested, so much alike that they might be considered as one species; the last named runs into the *C. coronata* of Mexico, and this into a South American kind called *C. galeata;* while from these last

another Mexican species, *C. diademata*, differs but little. These birds are more sombre in general plumage, than the *C. cristata* of the east, but still they are beautiful; they differ mainly in the varying extent of the sooty blackish and the blue, and in the precise character of the blue or white spots about the head. Our two kinds above named might be described almost in the same terms; they are grayish black with a faint blue shade, passing on the rump and abdomen into bright blue, which becomes even richer on the wings and tail; these last are barred with black. The chin is slightly streaked with whitish; otherwise, the whole head is glossy black, except that the crest is prettily faced in front with blue or bluish-white, and there are frequently whitish spots about the eyelids, as in a robin. It is the character of these head-markings, and the longer and fuller crest, that chiefly distinguishes the Long-crested from Steller's jay. Both are about a foot long, and nearly half as much in spread of wing; the wings and tail are each about half a foot. The sexes can hardly be told apart, though the male is a little the larger; the young rapidly come to resemble the parents; but when they leave the nest they lack the black bars on the wings and tail, and the head markings.

When I was travelling westward in the spring of 1864, I saw some of these jays in the Raton Mountains, in New Mexico, which I believe to be about their eastern limit, at least on that latitude, for they are strongly attached to pine-clad mountains, and, like Clarke's crow (*Picicorvus columbianus*) and the Blue-headed jay (*Gymnocokitta cyanocephala*), are found as high up as timber grows. In crossing the Rocky Mountains through Whipple's Pass, I did not happen to meet with any, though others before me had been more fortunate; to the westward still, in the lofty forests of the San Francisco Mountains, they were abundant, and at that time (July), had just reared their families, and were rambling through the tops of the trees together. The old birds were in sorry condition, and had literally a "crest-fallen" air, as if they felt they had lost their chief ornament, and were stuck full of pin-feathers besides. But when I came across them the third time, in the pineries about Fort Whipple, they were in good trim once more, and saucy as ever. They live in the mountainous parts of Arizona all the year, for they are able to endure pretty severe cold, being of hardy nature, and well clothed with very soft, thick plumage, while their food is such as can be procured at any sea-

son. Thus being non-migratory, their permanent habitat may be given with some accuracy; it includes the wooded Rocky Mountain region at large. To the north, and especially about the Columbia River, they become mixed up with Steller's jay, which is the boreal extreme, reaching into Alaska; while in the opposite direction they run into the *Cyanura coronata* on the Table Lands of Mexico.

The imposing crest of this jay merits more than a passing allusion. It does not acquire its full size and beauty, after the July moult, until the approach of cold weather; but late in the fall, and all through the winter, this ornament is as striking as at the breeding season. It grows to be two inches and a half long, and is composed of many slender feathers with loosened barbs. The longest ones grow from the crown, while shorter ones fill in from behind and before, to make an elegant pyramid when standing close together, or a bundle of plumes when shaken apart, as represented in the figure, taken from a perfect spring specimen. This crest is jet black, but it is trimmed in front with a lacing of bluish white, laid on in two rows running a third way up; the colored feathers are of a hard, dense nature, looking something like little bits of metal, and besides these, there are spots of like color about the eyelids, as already mentioned. The crest can be raised or lowered, and opened or shut at pleasure; and its rapid movements, when the bird is excited, are highly expressive. The jay seems to be proud of his top-knot, and generally holds it pretty high, unless he happens to be on a birds'-nesting expedition, which I am sorry to say is not seldom, when he lowers his standard, and makes himself as small as possible, as he skulks silently about, looking, and no doubt feeling, like the thief that he is.

All the jays make their share of noise in the world; they fret and scold about trifles, quarrel over nothing, and keep everything in a ferment when they are about. The particular kind we are now talking about is nowise behind his fellows in these respects: a stranger to modesty, and forbearance, and the many gentle qualities that charm us in some little birds and endear them to us, he is a regular fillibuster, ready for any sort of adventure, that promises sport or spoil, even if spiced with danger. Sometimes he prowls about alone, but oftener has a band of choice spirits with him, who keep each other in countenance — for our jay is a coward at heart like other bullies — and share the plunder on the usual

principle in such cases, of each one taking all he can get. Once I had a chance of seeing how a band of these guerillas make their raids, and though they went at it in good style, they came out very badly indeed. A vagabond troop made a descent upon a clump of bushes, where probably they expected to find eggs to suck, or at any rate some chance for mischief and amusement; and to their intense joy, they surprised a little owl, quietly digesting his grasshoppers, with both eyes shut. Here was a lark! and a chance to wipe out a part of the score that the jay family keep against the owl tribe, for injuries received time out of mind. In the tumult that ensued, the little birds scurried off at once, the woodpeckers overhead stopped tapping to listen and look on, and a snake that was basking in a sunny spot thought best to crawl into his hole. The jays lunged furiously at their enemy, who sat helpless, bewildered at the sudden onslaught, trying to look as big as possible, with his wings set for bucklers and his bill snapping, meanwhile twisting his head till I thought he would wring it off, trying to look all ways at once. The impudent jays, emboldened by the feeble resistance, grew more and more insolent, till their victim made a sudden break through their ranks, and flapped into the heart of a juniper tree, hoping to be screened by the tough, thick foliage. The jays went trooping after, of course, and I hardly know how the fight would have ended, but here I thought it time to interfere myself. I got the owl first, as the greater prize, it being the rare and curious Pigmy (*Glaucidium gnoma*) hardly bigger than a blue-bird; and shot four of the jays, before they made up their minds to be off. The collector has no better chance to enrich his cabinet, than when birds are quarrelling with each other; and so it has always been with the third party in a difficulty, ever since the monkey divided cheese for the two cats.

Since I have spoken of the jay's noisiness, I ought to say what his voice sounds like; but that is a hard matter, he is such a garrulous creature, and has such a variety of tones. Ordinarily, he screams out at the top of his voice, and keeps screaming till he is tired, or till something attracts his attention. This note is something like our jay's, but hoarser and heavier, and can be told in a moment, by its base quality, from the harsh outcry of either Woodhouse's or Maximillian's jay, both of which birds run higher up the scale. He has another way of expressing himself, that sounds like the rataplan of our golden-winged woodpecker; and then

again, when greedily regaling upon acorns, or hopping about with no particular object in view, or curiously peering down through the pine fronds to watch an intruder, he talks to himself in a queer way, as if thinking aloud and chuckling over some comical notions of his own; or perhaps simply because he likes to hear himself.

Indeed, this talkativeness gave the name — *Garrulinæ* — to the whole tribe of jays; and versatile as they are in this, they are equally so in the matter of their food, whence they used to be called *Omnivori*. The long-crested jay will eat anything that is eatable. They say jays kill and devour small birds; perhaps they may, but I do not think it is their practice. That they will rob birds' nests, and suck eggs, no one doubts; and if they cannot catch winged insects, fat larvæ and beetles do not come amiss. But after all, they are vegetarians, and live principally upon seeds, berries and other fruit. Out there in the mountains where the Long-crested lives, pine-seeds contribute in large part to his nourishment. I have often watched the bird hammering away at a cone, which sometimes he would wedge in a crotch, and sometimes hold with his feet, like a hawk with a mouse. Though most at home in the depths of the pines where the supply is pretty sure, he often strays into the adjoining patches of scrubby oak and juniper after the acorns and berries, or to pick a quarrel with Woodhouse's jay, and frighten the sparrows. Wherever he goes he has it pretty much his own way, hated and feared by the other birds, whom he silences with his scream, and subdues by a show of authority. But who of his ilk has not enemies to be feared in turn? Cassius' flycatcher, almost as noisy and audacious as himself, has many a set-to with him; and even the nimble little pewees pester him occasionally. The woodpeckers tease him particularly; they can scramble about faster than he can follow, and laugh at him from the other side of a bough, till he quite loses his temper.

But withal our jay has his good points, and I confess to a sneaking sort of regard for him. An elegant dashing fellow, of good presence if not good manners; a tough, wiry, independent creature, with sense enough to take precious good care of himself, as you would discover if you tried to get his skin. As you approach a tall pine where he is rollicking, his restless bright brown eye marks you for a suspicious character who will bear watching. Now thoroughly on the alert, he leaps like a squirrel from bough to bough till he reaches the top; and then, as you advance a step

nearer, he is off with a scream that makes the woods echo his triumphant disdain. It will be of no use to follow him, now that he is alarmed; give up the hope of that particular skin for your cabinet. But perhaps on another occasion he may be inclined to take a better look at you, for his curiosity is great, and so he may expose himself through the rift of the foliage that forms his look-out. That moment is your chance, and with the loud report of the gun comes his shriek of agony, as he falls all bloody from the bough he just mounted in such pride. If he is only wounded, you will find him game to the last, in such desperate strait as this, however he may show the white feather at other times; and you will have hard work to squeeze the last gasp out of him, with your fingers pressed on each side of the thorax, as you well know how. And even though you have a prize, you will think it is a cruel thing to do, as you plug up the shot holes, and thrust him in a stiff paper cone — especially guarding his superb crest — before consigning his warm body to the bag along with other victims.

REVIEWS.

Gray's Hand List of Birds.— With the third Part, which has appeared this year, one of the most remarkable ornithological works ever published is brought to a close. The urgent need of such a work as this has long been felt, while there seemed to be little hope that the want would be supplied, owing to the magnitude and exceptional difficulty of the task. Since Bonaparte's 'Conspectus,' with somewhat similar aim and scope, was abruptly broken off by the author's death, no one has hitherto been found willing, even if able, to bend himself to the undertaking. But Mr. Gray has proved equal to the occasion. To a knowledge of birds possessed by only a few leading ornithologists, he adds an acquaintance with the literature of the subject in which perhaps he stands alone; while the British Museum affords unrivalled facilities for one, who, like Mr. Gray, can use them to greatest advantage. To speak of the work in general terms of praise would be entirely superfluous. Mr. Gray has laid ornithologists under a lasting debt of gratitude.

The three unpretentious volumes simply purport to be a "hand-list of birds, distinguishing those contained in the British Museum:" but this does not say what has been accomplished, nor more than hint at the immense labor involved. This astonishing compilation is really an epitome of ornithological literature. It undertakes to present and identify all the generic and specific names that have been proposed in ornithology from the Linnæan times to to-day. And when we find that some five thousand generic titles, and over thirty thousand specific names, have been collated and identified, either as synonyms or as valid designations, we can appreciate what has been done. The index alone (which, by the way, takes up more than half the last volume) presupposes a familiarity with the literature of the science hardly to be expected in one man, to say nothing of the library work required in looking up authorities, and the mere clerical labor of transcription. But even this seems insignificant, when we recollect that two-thirds of the thirty thousand "species" are synonyms, and that an equal if not greater reduction of the five thousand "genera" was required; that this great mass of bibliographical matter had to be thoroughly digested, the valid species to be sifted out and assigned to other proper sub-genera and genera, and then the load of synonymy to be correctly distributed. Yet this has been approximately accomplished.

It is not within the bounds of possibility that all this should have been faultlessly done. In the first place, ornithological synonymy cannot now be completely disentangled; in every family, and in every extensive genus, there are names that cannot be identified to everybody's satisfaction. Secondly, the number of species cannot be fixed, owing to the well-known and unfortunate lack of agreement as to what shall be held for species and what for geographical or other differentiation. Supposing a man to have arranged before him every name that has been printed in ornithology, and to be personally acquainted with the bird upon which each one of these names was based; yet then he would not be able to pass judgment that would not be contested or reversed by some other equally well informed ornithologist in at least one case out of ten. In such insurmountable difficulty as this, Mr. Gray has adopted the most judicious — in fact the only practicable — course; he gives doubtful species the benefit of the doubt. It was manifestly impossible for him to attempt, in his individ-

ual capacity, critical discrimination in every instance; and the plan carried out is far more satisfactory. Suppressing only unquestionable synonyms, he retains all names not satisfactorily identified, and enumerates separately all geographical and other differentiations, in the cases of widely spread and flexible species, that have been distinguished by name. So in any given group we see at a glance what has been described as distinct, and may so be held with any show of reason whatever. As each name is accompanied by precise indication of locality, we can seize at once upon a probable indication of any specimen we may be looking up; and after determining that it is such a species of such an author, it remains with ourselves to decide whether it is sufficiently distinguished from such another species. Thus any one inclined to be severe in the matter of species can lump to his heart's content; whereas had Mr. Gray heaped up synonyms in a conservative spirit, he would have made it like looking for a needle in a haymow for one of opposite tendencies to pick out the name he wanted. By this method, Mr. Gray makes an approximation towards a perfect mirror of ornithological literature only limited by common human fallibility.

The list of species foots up a total of eleven thousand, one hundred and sixty-two, distributed among two thousand, nine hundred and fifteen genera and sub-genera. Making a reasonable reduction, upon the considerations just presented, the number probably will not exceed ten thousand — a figure that accords with current estimates. But the number of "genera" — one for every four species, and that in a class of animals of the fewest broad types, and an unusual proportion of closely interrelated forms — is a palpable absurdity. Mr. Gray, however, is not guilty of any such thing as this. The full genera he adopts are noticeably few — decidedly fewer than is now customary; at a rough estimate not one-fifth of the two thousand, nine hundred and fifteen names enumerated. For in this matter, he has been guided by the same happy judgment that dictated his disposal of specific names. In reducing the five thousand and odd genera that have been proposed to two thousand, nine hundred and fifteen, he suppresses only those that are positively homonymous — based upon the same type. The rest are given, as subgenera, each over its own type, without raising the question of their taxonomic value; thus among the humming birds, we find only twenty-eight

genera, but no less than one hundred and seventy-eight subgenera! By this means we learn exactly what, if any, names have been based upon a particular species; and so knowing the types, we can combine or keep separate at discretion. If Mr. Gray had brought these various names under the one he adopted for the genus, we should be completely at a loss. One other reason for the prodigious number of generic names indexed, may be found in a peculiarity of Mr. Gray's; he invariably preserves the original spelling of names, whether correct or not, against the custom of the purists who try to amend cacography, false etymologies, and other 'barbarities' of which ornithology is guilty; he will not even correct typographical errors ordinarily; and by citing all the different spellings of the same word as distinct synonyms, his list is considerably swelled, since the same word is sometimes written five or six different ways. For the special purposes of this work, this method is undoubtedly preferable, though obviously it cannot be fully carried out. For instance, in the 12th edition of the *Systema Naturæ*, the genus *Scolopax* stands printed *Scopolax*.

The classification adopted in the hand-list is fairly open to criticism on every score. If there is any point upon which ornithologists are almost unanimous in the midst of the taxonomic enterprises and conflicts of the present day, it is the entire ineligibility of this antiquated classification. Whatever may be said for or against any other system, this one at least will not do.

We hesitate about mentioning the only other feature of the work that does not satisfy us; for it is much like asking the master of a feast why he does not have one more course. But, while a large proportion of the species (the leading ones in particular) are indicated by references to the works where they are described, the greater number of names, including all the synonyms, are merely accompanied by the authors' names, and the locality. This will often leave the student in the lurch, as he may have no idea where to look for the description upon which the name is based. This is complimentary to ornithologists, certainly: but it presupposes a knowledge of the literature of the science that all do not possess. It was not so much matter about the synonyms; but if the line allotted to each species had been filled out with the reference, as it might have been, we should judge that with little additional labor, and without perceptibly enlarging the volumes, the usefulness of the work would have been ma-

terially enhanced. After what has gone before, we hardly need say, that the Hand-list is simply indispensable to the working ornithologist. — E. C.

ORIGIN OF LOWEST ORGANISMS.*—The author's aim in this and other writings is to prove that while some monads (Bacteria) originate by subdivision of preëxisting individuals (homogenesis), others originate *de novo*, just as crystals originate by certain chemical laws. He thus goes still farther than those advocates of spontaneous generation who believe that Bacteria originate by the transformation of living matter (heterogenesis). For this new mode of spontaneous generation he proposes the term "Archebiosis."

We should premise that Bacteria are monads, the lowest and most minute organized beings, forming mere points of organized matter; they are highly refractive spherical bodies, and move with considerable activity. Torulæ are very similar bodies and are the germs of the yeast fungus. Professor Bastian has observed the ordinary reproduction by fission "most plainly when a few Bacteria have been enclosed in a single drop of fluid, pressed into a very thin stratum, in a 'live box' kept at a temperature of about 90° Fahr. by resting on one of Stricker's warm water chambers placed on the stage of the microscope. Under these conditions, I have seen a Bacterium of moderate size divide into two, and each of these into two others somewhat smaller, in the course of fifteen minutes." These monas-like bodies, as is well known, develop into higher organisms. "It is a fact, however, admitted by many, and which any patient microscopist is capable of verifying for himself, that some Bacteria do develop into Leptothrix filaments, and that these are capable of passing into a dissepimated mycelial structure of larger size and undoubtedly fungus nature —from which, fructification of various kinds may be produced. Some Bacteria may therefore develop into some fungi, just as certainly as Torulæ may develop into some other fungi, or just as surely as some multiplying gonidia may develop into lichens. That some Bacteria are produced from preëxisting Bacteria, just as some Torulæ are derived from preëxisting Torulæ, may, it is

* The Mode of Origin of Lowest Organisms: including a discussion of the experiments of M. Pasteur, and a reply to some statements by Professors Huxley and Tyndall. By H. Charlton Bastian, London and N. York. Macmillan & Co. 1871. 12mo. pp. 109, with two cuts. $1.25.

true, be considered as settled." "But" he adds "so far as we have yet considered the subject, there may be just as good evidence to show that Bacteria and Torulæ are capable of arising *de novo*, as there is that some of them are capable of developing into fungi."

He next discusses the heterogenetic origin of Bacteria and Torulæ:—

"It has long been known that Bacteria and Torulæ are frequently to be found within vegetable cells, taken even from the central parts of plants whenever these are in a sickly condition or are actually dying. They are apt to exist also within epithelial cells taken from the inside of the mouth; and the frequency and abundance with which such organisms are met with in these cells, is almost in direct proportion to the malnutrition and lack of vital power in the individual who is the subject of observation. Then again, in persons who have died of adynamic diseases, in the course of twenty-four or thirty-six hours (during warm weather), Bacteria may be found in abundance within the blood vessels of the brain and of other parts, although no such Bacteria were recognizable in the blood of the individual during life.

In such cases we must in order to account for the presence of the Bacteria and Torulæ, either suppose that such organisms, in an embryonic state are almost universally disseminated throughout the various textures of higher organisms, both animal and vegetal (though they are only able to develop and manifest themselves when the higher organisms, or the parts of them in which the Bacteria or Torulæ are met with, are on the eve of death), or else we must imagine that when the vital activity of any organism, whether simple or complex, is on the wane, its constituent particles (being still portions of living matter) are capable of individualizing themselves, and of growing into the low organism in question. Just as the life of one of the cells of a higher organism may continue for some time after the death of the organism itself, so, in accordance with this latter view, may one of the particles of such a cell be supposed to continue to live after even cell-life is impossible."

This latter theory (heterogenesis) he favors as in part accounting for the production of Bacteria, as "evidence of a tolerably satisfactory nature, however, is forthcoming which may speak independently in favor of the doctrine of heterogenesis."

"It has been affirmed by Crivelli and Maggi that they have actually seen the particles within granular epithelial cells (taken from the back of the tongue of a patient suffering from diabetes) grow and elongate, so as to give rise to Bacteria, or fuse in longitudinal series so as to form a Vibrio. And, moreover, as I have

myself ascertained, if one takes healthy-looking epithelial scales scraped from the inside of the mouth, which appear to contain nothing but the finest granules, and places them with a little saliva in a 'live box' (and this within a damp chamber kept at a temperature of about 90° Fahr.), in the course of from five to ten hours, the cells may be found to be studded throughout with motionless Bacteria."

The origin, in the third place, of Bacteria and Torulæ by Archebiosis is supported by evidence, in the author's opinion, sharply defined and conclusive.

"Simple experiments can be had recourse to, which are not admissible in the discussion of the question as to the origin of Bacteria and Torulæ by Heterogenesis. Thus, we wish to establish the fact that living matter is capable of undergoing a certain metamorphosis, and consequently, we must deal with living matter. Here, however, with the view of establishing the fact that living matter can arise *de novo*, if we are able, shortly after beginning our experiment, to arrive at a reasonable and well based assurance that no living thing exists in the hermetically sealed experimental vessel — if the measures that we have adopted fully entitle us to believe that all living things which may have preëxisted therein have been killed — we may feel pretty sure that any living organisms which are subsequently found, when the vessel is broken, must have originated from some re-arrangements which had taken place amongst the not-living constituents of the experimental solutions, whereby life-initiating combinations had been formed."

The possibility of this mode of spontaneous generation is "intimately associated with the doctrine as to the cause of fermentation and putrefaction. Bastian espouses Liebig's theory of the cause of fermentation, *i. e.*, by sets of chemical changes, against Pasteur's, who believes that fermentative changes are begun by the influence of living organisms.

He also attacks the theory that the atmosphere is laden with the germs of Bacteria and Torulæ, and thinks that if they do have germs, they must be microscopically invisible to us. He then gives the results of a series of experiments which "seem to show quite conclusively that M. Pasteur's explanations are altogether inadequate to account for the occasional preservation of boiled fluids in bent-neck flasks." They lend no countenance, moreover, to his particular theory, that fermentation cannot be initiated without the agency of living ferments, — they are, on the contrary, wholly opposed to this restriction. In conclusion our author remarks: —

"It would thus appear that specks of living matter may be born in suitable fluids, just as specks of crystalline matter may arise in other fluids. Both processes are really alike inexplicable—both products are similarly the result of the operation of inscrutable natural laws, and what seem to be inherent molecular affinities. The properties of living matter, just as much as the properties of crystalline matter, are dependent upon the number, kind, and mode of collocation of the atoms and molecules entering into its composition. There is no more reason for a belief in the existence of a special "vital force," than there is for a similar belief in the existence of a special "crystalline force." The ultimate elements of living matter are in all probability highly complex, whilst those of crystalline matter are comparatively simple. Living matter develops into Organisms of different kinds, whilst crystalline matter grows into Crystals of diverse shapes. The greater modifiability of living matter, and the reproductive property by which it is essentially distinguished from crystalline matter, seem both alike referable to the great molecular complexity and mobility of the former. Crystals are statical, whilst organisms are dynamical aggregates, though the evolutions of both marked by their peculiar characteristics, may be regarded as visible expressions testifying to the existence of one all-pervading power—

> "Whose dwelling is the light of setting suns,
> And the round ocean, and the living air,
> And the blue sky, and in the mind of man:
> A motion and a spirit that impels
> All thinking things, all objects of all thought,
> And rolls through all things."

NATURAL HISTORY MISCELLANY.

BOTANY.

On the Lever-like Anthers in Salvia.—It must, I think, be evident to many observers that what we are prone to consider beautiful adaptations in the organs of flowers, are, as we should say of many of the operations of men, merely *afterthoughts;* that is to say that often parts would be formed without any idea of the uses which would be subsequently made of them. I have perceived this for some time, but hardly dared express it in the face of the universal belief that everything was designed for some special use and purpose. Last year, however, I submitted in these pages the

idea that if the petaloid lobes of the divided anthers in Salvia, which closed the throat of the corolla in most of the species, were really designed to aid in the diffusion of the pollen by insect agency, the subsequent clasping of the stamens by the upper lip of *Salvia involucrata* and thus preventing the said action, was a queer proceeding.

I hope that this matter will not be lost sight of by those who advocate the universal adaptation theory, and to aid in keeping the subject fresh, I would point out that in *Salvia coccinea* the "lever" arrangement exists as in most other Salvias, but are set back against the upper surface of the corolla, in such a way as to be absolutely useless as an obstruction of the throat, or for any purpose whatever that I can see. It is getting to be the fashion to refer any useless organs or structures to some supposed distant progenitors, from which the modern organism sprung. Our whiskers and so forth for instance, are said really to belong to the monkey from which we are descended, rather than to the modern man to whom they are now attached. It will be a curious study for botanists to trace out the progenitors of these Salvias which may claim the original uses of these petaloid anthers in cases where they are as useless now as the hair on our faces. But if we may be pardoned for deriding easy beliefs, as well as easy labors, we may say of some of these matters, as we say of pollen or of seeds themselves, that nature makes numberless things, for which she has no use whatever. Perhaps it may be, that like the human mind, the mind of nature likes variety and profusion, in the effort for which mere utility is not always consulted.—THOMAS MEEHAN.

[Should Mr. Meehan read E. Müller's Discourse, in the July number of the NATURALIST, he will notice that, with the Darwinian school, and in virtue of the very terms of the theory which has imparted so much interest into the subject, "universal adaptation" is regarded as a consequence rather than as a forethought. Thus far he would seem to be in accord with Darwinians. But in nothing could he more widely diverge from their way of thinking than in his suggestions that "Nature makes numberless things for which she has no use whatever," if by his metaphorical expression he means that the "things" are of no use to the beings that produce them. And of this sort, "pollen and seeds" are queer examples. Does he mean that these are useless because superabundant enough to ensure against risk and loss and appropri-

ation by animals, through which fertilization and dispersion are subserved? — Eds.]

Petals in Atragene. — I have just taken a number of specimens of *Clematis* (*Atragene*) *alpina* which have well developed petals. In the subgenus Atragene, as is well known, the outermost of the stamens are usually abortive, as if to represent the true petals, which are wanting. I have in one flower, not less than ten good petals, all of them being as long as the sepals, two-thirds as broad, and quite as deeply colored.

These petals are all entirely destitute of any traces of the anther at their tips; nevertheless, in all the specimens in question, the transition from stamen to petal, is a gradual one, similar to what is seen in the flowers of Nymphœa. The usual four sepals are perfectly normal, and differ from the petals only in being broader. — Edward L. Greene, *Golden City, Col. Territory.*

Transpiration of Leaves. — In the monthly report of the Department of Agriculture for March and April, 1871, page 149, is a short notice on transpiration of leaves. Pettenkofer is named as the observer, but he only made the report of the experiment, which was performed by Prof. Fred Pfaff in Erlangen. Being on a visit to Germany two years ago and standing under the same oak tree, which was the object of the observation, my old friend Mr. Pfaff explained to me his mode of calculations, which may be of interest to some of your readers.

Cutting a small twig with the leaves, he brought it in a wide mouthed glass bottle, corked and weighed it. Then he exposed the leaves to the open air, weighed it again, after three to four minutes and marked the differences, from which he calculated the evaporation of the leaves in a certain time. Then he outlined each of the leaves on fine paper, the weight and measure of which he had ascertained, cut the outlines out and weighed these again; from the difference of weight he calculated the difference of measure, and accordingly the surface of all the leaves. Afterwards he calculated the surface of the foliage of the whole tree in the following manner: the crown of the tree was a regular elipsoid and easily measured; deducting the inner leafless part, he found the bulk of the leafed part. Attaching cubes of different sizes, made of thin sticks representing the edges of the cube, to parts of the

crown of different density of foliage, he counted the leaves falling into the hollow space and calculated by repeated measurements the average number of leaves of the whole tree and the average surface of them.

The loss by evaporation was measured at different hours of each day, from the 18th of May to 24th of October; this reduced the average loss for a square inch surface, and from this was calculated the average loss from all the leaves of the tree during the season.

Many minute precautions were taken, which to mention here is not necessary; but it may be remarked that when exposing the leaves for evaporation he suspended the twigs in the shade, and as the cut twigs during the experiment were deprived of any succor from the tree, the loss is to be considered as a minimum.

The intention was not to find the exact amount of transpiration, but to prove that during the season the tree evaporates considerably more water than it receives by rainfall, and so the method answers the purpose. — FRED. BRENDEL, *Peoria, Ill., 9th of June*, 1871.

ZOOLOGY.

SPAWNING OF THE GOOSE FISH (*Lophius Americanus*). — During the summer season the fishermen on the New England coast often notice a substance floating in the water, which they term "a purple veil" the precise nature of which has caused much speculation on their part, and which answers singularly well to its designation.

During a late cruise I encountered one of these veils, which presented the appearance of a continuous sheet of a purplish brown color, twenty or thirty feet in length and four or five in width, composed of a mucous substance which was perfectly transparent, to which, as a whole, a purple color was imparted by the presence of specks distributed uniformly throughout the mass to the number of about thirty or more to the square inch. I was unable to ascertain whether this was actually a simple sheet or a collapsed tube, as the material was so extremely slippery that it was impossible to retain it in a position where it could be easily examined. With much effort we succeeded in bringing a portion upon the deck of our boat, when it ran out almost immediately through the scupper holes. To our surprise on closely examining the specks, which gave color to the mass, we found them to consist of embryonic fish, moving vigorously in their envelope but without

any appreciable latitude of motion, or change of relative position to each other.

Portions of this veil, with its contents were brought home, hoping that we might be able to follow the successive transformations of this embryo, and thereby determine the species; but although the water in which they were kept was frequently changed they very soon died.

It was, of course, evident that nothing but a very large fish could lay so heavy a sheet of mucus, covering as it did an area of not less than from sixty to one hundred square feet, and I am informed that they are sometimes found even much larger than this. Allowing one hundred square feet of surface, and an average of thirty feet to the square inch, the sheet in question would contain four hundred and thirty-two thousand eggs, an estimate decidedly within the mark.

When this specimen was first selected, we had overboard at the stern of our boat a trawl net about thirty feet in length, of a tan color trailing behind, and the veil was first seen floating near it, and so entirely similar in general appearance and color, as to remain for some time without attracting special attention, till one end floated off from that of the net, creating the impression that the latter had been torn longitudinally into strips by some unknown accident.

Finding myself unable to ascertain anything about the true character of this spawn I sent specimens of it to Mr. Alexander Agassiz, who informed me that it belonged to the goose fish, and that he had studied out the development of the species from its earliest stage of growth to maturity.—S. F. Baird.

How Living Toads May Occur in Limestones.—It is well known to all naturalists that none of the existing species of animals were in existence during either the paleozoic or mesozoic periods, and hence the reported occurrence of frogs or toads in a torpid but living state, embedded in solid limestone strata, has not been generally credited by scientific men as worthy of serious consideration. Nevertheless it is not uncommon to hear persons assert that such occurrences have taken place within their own personal knowledge, and it seems hardly probable that such reports should arise in various and distant localities, without some apparent foundation in fact.

In the winter of 1853 the writer was informed by a gentleman

of undoubted veracity, that in laying the foundation walls for a warehouse in the town of Naples on the Illinois river, a living toad was found entombed in the limestone, which on coming in contact with the atmosphere soon resumed its wonted activity, though torpid when first discovered.

Having occasion to pass through Naples a few days afterwards, I examined the walls of the buildings to see if I could discover any clue that might serve to explain so improbable an occurrence. I found the walls constructed out of the brown dolomite of the lower St. Louis, or Warsaw limestone, and observed that the rock had been more or less fissured, the fissures cutting the strata at right angles to the lines of bedding, and varying from a mere line to an inch or more in width. Many of these fissures had been filled wholly or partially with a deposit of stalagmite, and in some places the exposed surface of the rock had been coated for an inch or more in thickness with the same material.

These facts seemed to me to afford an easy explanation of the reported phenomena; the toad had sought shelter in one of these crevices as his home for the winter, where he remained in a dormant condition, until the constant dripping of water holding carbonate of lime in solution sealed him in completely. Here he remained until he was released by the hammer of the workman, which broke the crust of his stony mausoleum, and restored him to liberty. Persons who had paid no attention to the manner in which limestones are formed, would make no distinction between the original dolomite which was formed beneath the ocean, eons of ages ago, and the incrusting stalagmite whose formation is still going on, and to them it would be all alike, *solid limestone*. As these comparatively recent calcareous deposits are of very common occurrence, it would not be surprising that living batrachians should be found in them, even more frequently than they are.

It would be a matter of considerable scientific interest, to determine, were it possible, how long animal life could be preserved under such conditions; and if the functions of life are so completely suspended during hibernation, as to cause no waste of tissue, I see no reason why it might not be preserved for an indefinite period, though it is by no means necessary to suppose in the case cited above, that any long period had elapsed after the entombment of the animal.—A. H. Worthen, *Springfield, Ill.*

Young Worms Feeding on Eggs of the Same Brood.—In a recent biography of the celebrated Swiss naturalist Claparède, by M. H. de Saussure, published in the "Bibliotheque Universelle," he is said to have made the strange discovery that among the eggs contained in great numbers in the capsule secreted by the worm (Clitellum) one only transforms into an embryo. This rapidly increases in size, since as soon as its mouth is formed, it devours the surrounding eggs, which thus serve as a reservoir of food. This phenomenon is analogous to that which has been described in certain gastropodous molluscs such as Purpura, etc.

Black Varnished Insect Pins.—M. Peyerimhoff advocates the use of black varnished insect pins instead of silvered brass pins, which corrode in the body of the insects, especially of Micro-Lepidoptera, very soon disfigure them, and eventually utterly destroy them. The editor of "Petites Nouvelles Entomologiques," thinks that varnished brass pins may last somewhat longer, but that these will eventually perish in the same way. "We believe that platinum wire is perfectly indestructible, and open to none of the objections which are made to brass. Certainly nothing but platinum will therefore be used for very rare specimens."

Hymenopterous Parasites in a Beetle.—Wishing to compare certain muscles of locomotion of butterflies with those of some other insect, I selected from a bottle of alcoholic specimens a species of Pimelia which I had collected in Egypt—a large, compact, very hard-shelled beetle, with elytra connate to the last degree. On opening the beetle from above and removing the mass of nearly or quite developed eggs which lay on the upper surface, I noticed some vermiform bodies lying free in the cavity of the abdomen. Examining them carefully, my astonishment was great on discovering that they were hymenopterous larvæ, closely resembling those of certain species of Braconidæ which are so easily reared from some lepidopterous larvæ. I had detected several when I was called away, and was afterwards unable to distinguish from the dried up mass how many larvæ it might have contained. Have hymenopterous larvæ ever before been found parasitic in the abdominal cavity of a perfect hexapod? Least of all should we expect to find them in such hard-shelled Coleoptera? How and

when do they emerge from their host, and do they interfere with its vital functions before the eggs are deposited? The beetle was one of a large colony of lively specimens captured beneath the ruined walls of an Arab hovel at Ismailia on the Suez canal. The specimens have been sent to the editors of the AMERICAN NATURALIST. — SAMUEL H. SCUDDER.

[It is well known in Europe that several species of Conops, a wasp-like dipterous fly, live in the larva state in the abdomens of adult humble bees. We have reared a species also from the abdomen either of *Bombus vagans* or *B. fervidus*. — EDS.]

MADNESS IN A HORSE. — In the "Zeitschrift für Parasitenkunde" published in Berlin, a remarkable instance is recorded of madness in a horse, caused presumably by the bite of a mad dog. The horse was brought to the hospital of the Royal Veterinary School at Berlin, having refused its food for two days, and exhibited extraordinary wildness and propensity to bite, not only other horses and inanimate objects, but also its own body, and had already by this means broken several of its teeth, and inflicted severe injuries on its mouth. When confined in a stall in the hospital, it continued to exhibit this propensity to a terrible extent, but in a fitful manner; in the intervals of the paroxysms it stood in a bewildered state, and would sometimes suddenly fall as if struck by lightning, then give a violent bite to one of its hind feet, then as suddenly spring up, staggering. The loss of blood caused it to become gradually weaker, and in the evening of the day on which it was admitted, it expired without any death-struggle. Except the outward injuries, and some interior swelling and inflammation, the organs were found to be sound after death. — A. W. B.

ANTHROPOLOGY.

WHERE ARE THE BONES OF PREHISTORIC MEN? — In answer to this inquiry, M. W. Pengelly states in the "Quarterly Journal of Science" that their bones may be more subject to decay than the bones of other animals, citing the experiments of Dr. Lindley who "placed in water, in a tank, one hundred and seventy-seven specimens of various plants belonging to all the more remarkable natural orders, including representatives of all those which are constantly present in the coal measures, and also those which are

universally absent. The uncovered vessel was exposed to the air and left untouched further than filling it up as the water evaporated, until April, 1835, or a period of two years. At the end of that time it was found that certain kinds had entirely disappeared, others had left some more or less recognizable traces; whilst others, especially fungi, ferns and coniferous trees were comparatively well preserved. In short, the plants remaining and the plants which had disappeared were respectively of the same groups as those which are not present amongst the coal fossils." He also remarks that it is well known that oyster and limpet shells are more frequently found fossil than cockles, and it was found by Mr. Sorby that the carbonate of lime in the shells of limpets, oysters and other molluscs, were turned into calcite, while cockles and their allies were changed into arragonite, the latter being liable to disappear. He also says that after the conversion of the Lake of Haarlem into dry land, when thirty to forty thousand men had been buried in its land, or drowned in its waters, and thousands of miles of trenches and canals were dug through this made land, no human bones had been found, and only a few relics of human art. As direct evidence that the bones of man have been found mingled with those of extinct animals, he cites the following facts:—In 1824 Rev. Dr. Fleming stated that "man was an inhabitant of this country at the time these animals, now extinct, flourished, his bones and his instruments having been found in similar situations with their remains." M. Wrey, F. G. S., in 1831, discovered "an undoubted human skull, very perfect and in good preservation" in the floor of a cave, mingled with the bones of "extinct and recent animals." In 1833–'4, Dr. Schmerling of Liège, in a cave in the valley of the Meuse, discovered certain deposits which "were covered with a floor of unbroken stalagmite, and contained the commingled remains of extinct and recent animals, including man," among which were several skulls, including the celebrated Engis skull. In 1840, Mr. Godwin Austin remarked that the bones of man occurred in Kent's Cavern, Torquay, "under precisely the same conditions as the bones of all the other animals." In 1841 he added, "at Kent's Hole, near Torquay, arrows and knives of flint, with human bones, in the same condition as the elephant and other bones, were found in an undisturbed bed of clay, covered by nine feet of stalagmite."

"The late Col. Hamilton Smith devoted a section of his "Natu-

ral History of the Human Species" (1848), to the question of "Bones of Man among Organic Remains" of which the following is a brief summary:—In a conversation with the author in 1824, Cuvier admitted that the opinions then in vogue on the point would require considerable modification. Donati, Germer, Rasoumouski, and Guetard, maintained that human bones had been found intermixed with those of lost species of mammals in several places; they had been detected in England in caves and fissures; they were found at Meissen in Saxony, and at Darford in France, by M. Firmas. A fossilized skeleton found in the schist at Quebec, and in part preserved at the seminary, excited no attention; and the well known Guadaloupe skeletons had been pronounced recent upon hypothetical reasoning. Those discovered by M. Schmerling in the Liège caverns were similarly disposed of, and Dr. Lund's reports respecting partially petrified human bones, found by him in the interior of Brazil, in the same condition with those of numerous animals, now extinct, which accompanied them, attracted no more than incredulous attention. In the caverns of Bize, in France, human bones and shreds of pottery were found in red clay mixed with the dèbris of extinct mammalia; a similar collocation was soon after detected by M. de Serres, in the caverns of Pondres and Souvignargues; and Dr. Boué found human bones mixed with others of extinct species at Lahr. In 1833, human bones were found together with several species of the well known extinct cave mammals, in caves near Liège, beneath a thick coat of stalagmite; and about the same period, the Rev. Mr. MacEmery collected from the caves of Torquay, human bones and flint knives, amongst a great variety of extinct species, all under a crust of stalagmite upon which the head of a wolf reposed. Amongst the bones of the mammoth and his contemporaries, found at Oreston, near Plymouth, at different times before and after that period, the upper portion of the humerus of a man was detected, and immediately thrown away as valueless on being pointed out to the possessor. About the end of the last century, gypsum quarries were opened in the Vale of Kostniz, in Upper Saxony. The gypsum was intersected in every direction by caves and fissures, which were filled with red clay containing clusters of bones of mammalia, including man, elephant, rhinoceros, horse, ox, elk, deer, reindeer, a great felis, hyæna, hare, and rabbit. A fragment of an a m and a thigh-bone of a man were dug out of the clay at a

depth of eighteen feet; and eight feet below, two phalanges of a rhinoceros."

Other discoveries, made since 1860, and well known to our readers, are alluded to. The writer might have added the case, now apparently well authenticated, of the human skull found by Professor Whitney, under Table Mountain, California, associated with remains of the mastodon.

Fresh Discoveries of Platycnemic Men in Denbighshire.—Mr. W. Boyd Dawkins records in "Nature" the opening of some freshly discovered bone-caves in Denbighshire, Wales, in which were discovered the remains of men with the skulls rather above than below the present ordinary cranial capacity, but with some of the leg-bones remarkable for the peculiar antero-posterior flattening or platycnemism of the shin bones. They are associated with the remains of sheep or goat, pig, fox, badger and stag, and with four flint flakes. The interest of the discovery consists in the fact that the group of caves, which has been used by a race of herdsmen in long-forgotten times as habitations and burial places, must be referred to the Neolithic age. And we can now be certain that those people who have manifested the peculiar flattening forwards of the shin in Denbighshire belong to that age. It is a point also well worthy of note that the cranial capacity of these Neolithic men was not inferior to that of the average civilized man, although the ridges and processes for muscles indicated a greater physical power.—A. W. B.

GEOLOGY.

Geological Expedition to Kansas.—I write to give a brief account of the expedition of seventeen days which I have just made in the valley of the Smoky Hill river in Kansas. Through the courtesy of General John Pope commanding the department of the Missouri, I was furnished with an order on the post commandant at Fort Wallace for a suitable escort. This was furnished by Captain E. Butler (Fifth infantry), who spared no pains to make the expedition a success.

We first camped at a spring eighteen miles south of Fort Wallace, and five miles south of Butte Creek. It had a fine flow of water, and being without a name I called it Fossil Spring. On a bluff on Butte Creek, Lieutenant Whitten discovered the frag-

ments of a monster saurian projecting from the shale, and on following the bones into the hill, exhumed a large part of the skeleton of a *Liodon dyspelor* Cope. This was welcome, as the species had been previously known from vertebræ only. The pelvic arch was found perfectly preserved, and the scapular arch and limbs partially so. The iliac bone is slender and straight, slightly expanded at the acetabulum. The ischium has a some what similar form, but is curved. The axis of the proximal portion is directed upwards, the shaft then turns into a horizontal direction and lies beneath and at one side of the vertebral column without uniting with its fellow. The pubes are elongate, but wider than the other elements and flattened. They are in contact in front medially, and have an angulate axis. A short process projects from near the proximal end, on the exterior margin. The femur is a flat bone slightly constricted medially, and with a decurved and projecting portion of the proximal articular surface on the *inner side* representing a head. The extremities of the dentary bones are each drawn to an acute point differing thus *toto cælo* from those of the *L. proriger*.

On the same bluff another Liodon and a Clidastes were found with five species of fishes.

On examining the neighboring bluff and denuded areas, bones supposed to be those of Pterodactyle, two species of Clidastes, a Dinosaur, a Crocodile, and numerous fishes were brought to light.

In a similar location on Fox creek cañon, one of the escort, Martin V. Hartwell, to whom I am indebted for many fine discoveries, observed the almost entire skeleton of a large fish, furnished with an uncommonly powerful offensive dentition. The jaws were stout, the dentary bone very deep. The teeth in a single row in all the bones, but of irregular sizes. There are two or three very large canines in each maxillary and one in the premaxillary; three or four in the dentary separated by one interval. The lack of the coronoid bone and many other characters, shows that it should be referred to the order Isospondyli, and is probably allied to the herring and the Saurodontidæ. The vertebræ are grooved, and there is a basioccipital tube but little developed. The teeth are simple cylindric conic, with smooth enamel, and project two inches above the alveolar border, and each descends an inch into its alveolus. The species and genus are new to our palæontology, and may be named *Portheus molossus*. It turned out on subsequent explanation to have been quite abundant in the

Cretaceous seas. It was probably the dread of its cotemporaries among the fishes as well as the smaller saurians.

On another occasion we detected unusually attenuated bones projecting from the side of a low bluff of yellow chalk, and some pains were taken to uncover them. They were found to belong to a singular reptile of affinities perhaps to the Testudinata, this point remaining uncertain. Instead of being expanded into a carapace, the ribs are slender and flat. The tubercular portion is expanded into a transverse shield to beyond the capitular articulation, which thus projects as it were in the midst of a flat plate. These plates have radiating lines of growth to the circumference, which is dentate. Above each rib was a large flat ossification of much tenuity, and digitate on the margins, which appear to represent the dermo-ossification of the tortoises. Two of these bones were recovered, each two feet across. The femur resembles in some measure that ascribed by Leidy to *Platecarpus tympaniticus*, while the phalanges are of great size. Those of one series measure eight inches and a half in length, and are very stout, indicating a length of limb of seven feet at least. The whole expanse would thus be beyond twenty feet if estimated on a Chelonian basis. The proper reference of this species cannot now be made, but both it and the genus are clearly new to science, and its affinities not very near to those known. Not the least of its peculiarities is the great tenuity of all the bones. It may be called *Protostega gigas*.

The greater part of a large *Liodon proriger* Cope was found scattered over a denuded surface at one point, his huge, truncate bowsprit-like snout betraying his individuality at once. Portions of other examples of this reptile were afterwards found. Remains of several species of Clidastes occurred at various points in the neighborhood of Fossil spring. One (*C. dux* sp. n.) was found in the side of a bluff fifty feet above the bottom of the cañon; Martin Hartwell exhumed another near the *C. cineriarum* Cope almost complete.

We subsequently left this locality and encamped at Russell springs on the Smoky Hill, twenty-six miles distant. On the way a large Clidastes of some forty or more feet in length was found lying on a knoll of shale, with the head displaying the palatal surface upwards. On the Smoky our explorations were attended with success. When we shifted camp, it was to go to Eagle Tail in Colorado, whence we returned again to Fossil Spring. The

richness of this locality was again apparent, and we added to our collection a number of species, among these may be mentioned *Liodon ictericus* Cope and a new Clidastes.

The writer originally pointed out the existence of representatives of the orders Pythonomorpha and Sauropterygia, in this Cretaceous basin. Prof. Marsh's explorations determined the existence of Ornithosauria and Crocodilia. The present investigation adds Dinosauria and perhaps Testudinata, or the group the new form Protostega Cope, represents.

The preceding account expresses some points of interest observed. These with others now unnoticed will be included in a final report.

The giants of this sea were the *Liodon proriger* Cope, *L. dyspelor* Cope, *Polycotylus latipinnis* Cope, and *Elasmosaurus platyurus* Cope. Of these the first was apparently the most abundant. The second was the most elongate, exceeding in length perhaps any other known reptile. The last named had the most massive body, and exhibited the most extraordinary appearance in consequence of the great length of its neck.

For kind assistance I am much indebted to Captain Edwin Butler post commandant at Fort Wallace; to Dr. W. H. King post surgeon; and to Captain Wyllys Lyman. To Lieutenant James H. Whitten and Sergeant W. Gardiner who accompanied the expedition much of its success is also due. — Edward D. Cope, *Fort Wallace, Kansas, Oct. 9th*, 1871.

MICROSCOPY.

Ahrens' Binocular.— This instrument, the fourth new binocular brought forward within a few months, was submitted to the Royal Microscopical Society, of London, on the eighth of February last. It is applicable mainly to high powers, being manifestly unable to compete with Wenham's arrangement for low powers. It naturally stands in comparison with the contrivances of Mr. Tolles and President Barnard. Like Dr. Barnard's, which was published some months previously, it separates the light above the objective into two pencils by double refraction by means of Iceland spar, cut and cemented in a somewhat complicated and difficult manner. In other respects the two instruments are entirely different. In the new arrangement the pencils of light pass upward from the prism

at an equal angle on each side of the axis of the instrument, are crossed and at the same time rendered achromatic by wedge-shaped prisms of flint glass placed base to base, and proceed to the two eye-pieces through tubes symmetrically situated in reference to the axis of the instrument, as in Mr. Wenham's early proposals for refracting binoculars. Adjustment for distance of eyes is made, as in Wenham's present arrangement, by a draw-tube movement. In stereoscopic effect, as well as in illumination (only one of the two polarized rays being utilized), the new arrangement is no doubt inferior to Tolles' binocular eye-piece, but it possesses the great advantage of enabling the eyes to look at the object, through the convergent tubes, at the natural angle of near vision. It may be made in the form of an eye-piece applicable to any large stand; or, more satisfactorily, as a supplementary compound body capable of being easily fitted to any stand of suitable size, and of being used interchangeably with the regular body belonging to the stand. — R. H. Ward.

Nature of Ciliary Movement. — Professor Hæckel has made some highly important observations on the nature of ciliary movement, as we find in the "Quarterly Journal of Microscopical Science." Recent investigations by others had shown that physiologically the ciliary is much more nearly related to the amœboid movement than to the muscular. Hæckel shows that the ciliary is merely a modification of the amœboid movement of protoplasm. "Ciliated cells are of two kinds. In the one kind, *Epithelium flagellatum*, each cell is provided with a single long flagellum or lash. Sponges possess only this kind; in the other, *Epithelium ciliatum*, numerous hair-like appendages take the place of the flagellum. This is the kind found in most of the higher animals. The old notion, that in ciliated cells the cilia are attached to the outside of the cell membrane, must now be considered as entirely set aside. Many, probably most, ciliated cells are destitute of a membrane, and the appendages, whether flagella or cilia, are direct processes of the protoplasm of the cell." Prof. Hæckel's observations on lower organisms during the last year have led him to the conclusion that ciliated cells arise directly by the transmutation of amœboid cells.

Combination of the Spectroscope and Polariscope. — Mr. Francis Deas has introduced to the Royal Society of Edinburgh

a very curious department of microscopical study, the details of which are published in the "Monthly Microscopical Journal." He combines the spectroscope with the polarizing microscope, in order to analyze the colors given by double refracting crystals when viewed by polarized light. In his arrangement, the light from the mirror passes first through an adjustable slit below the substage, then through a Nicol's prism and the achromatic condenser, and forms an image of the slit on the double refracting crystal on the stage. The dispersion prisms are placed above the objective, and the spectrum is viewed with the eye-piece and analyzing prism. Those who prefer to use the spectroscopic eye-piece, as most do in this country, would dispense with the slit below the substage, and place the analyzing prism over the objective.

A High One-fifth. — Assist. Surg. J. J. Woodward, U. S. A., resolves *Amphipleura pellucida* with a Tolles' immersion one-fifth. This is a high one-fifth, but much less than a one-sixth in power. Angular aperture 110° to 170° according to adjustment. As these lines count ninety-six thousand to the inch, Dr. Woodward expected that it might resolve the sixteenth band of Nobert's plate. He only succeeded, however, in getting through the fifteenth band. This result corresponds with his judgment, based upon other observations, that Nobert's lines are more difficult of resolution than lines of equal fineness on the natural objects usually studied in comparison with them.

Fresh-water Algæ. — Dr. T. C. Hilgard's paper on this subject, read before the Microscopical Section of the American Association at the Indianapolis meeting, was inadvertently omitted from the list of papers published in the Association Number of the Naturalist.

Photographing Histological Preparations. — Dr. Woodward describes in the "American Journal of Science and Arts" for October certain improved methods of using the light of the sun for photographing the soft tissues.

Nobert's Lines.—President Barnard judges that it is not necessary to count the whole of one of Nobert's bands in order to resolve it unmistakably, but only to count a measured portion of a band.

STANISTREET'S LINES. — John F. Stanistreet, Esq., of Liverpool, has ruled some stars on glass and steel, the rays of which, some fifty in number, consist of bands of parallel lines two thousand to the inch. The intersection of these different lines gives very curious and beautiful optical effects under the microscope.

MICROSCOPY IN PARIS. — We learn from the "Quarterly Journal of Microscopical Science" that Hartnack is back at Paris, just as he was before the war. He is about to establish works at Potsdam.

NOTES.

"A very large audience, consisting of the teachers in Boston, assembled early in November, in the new hall of the Massachusetts Institute of Technology to attend the opening of a series of lectures upon Methods of Instruction in Natural History.

As it was the first time this hall had been publicly used, Professor Runkle, President of the Massachusetts Institute of Technology, opened the proceedings and introduced, in a few appropriate words of welcome, Mr. Thomas T. Bouvé, President of the Boston Society of Natural History.

Mr. Bouvé stated that the society which he represented had for many years by its publications and meetings, but more especially by the display of natural objects in its Museum, appealed to the public mind and endeavored to cultivate a taste for science in the community. The Teachers' School of Science was a very appropriate supplement to the other operations of the society and had been in contemplation by several officers of the society for some time past. The present active beginning, however, was due to the generosity of one of these gentlemen who had furnished the pecuniary means for making the necessary collections and paying the lecturers. The enterprise, however, was considered as an experiment to be worked out rather than talked about, and he would therefore without further delay introduce Prof. W. H. Niles, who would deliver the first course on 'Physical Geography.'

Prof. Niles made a few preliminary remarks upon the necessity of teaching science in the schools in a practical manner, and showed that the projectors of the enterprise had no intention of forcing theories upon the minds of the teachers. They simply wished to help, to join with them in their efforts to educate the young, and to place before them such information as their special acquirements in different branches of knowledge would justify.

He then proposed an elementary exercise which should embrace the definition and general relations of natural objects, proposing to teach it as if the audience were a class and he the teacher.

This was unanimously assented to, and he led them, by a series of carefully worded questions, from the definition of what a material body is to the classification of objects into artificial and natural, inorganic and organic, and the subdivision of these into mineral, vegetable and animal.

In a few concluding remarks the lecturer spoke of the general incompleteness of definitions, but also showed that they were essential to the analytical method of teaching, and, when used with the careful exclusion of all doubtful facts, of great use in classifying natural objects.

This principle was amply illustrated by the objects on the table. It was really surprising to witness how much might be done with such simple things as a piece of marble, an apple, a plant, a squirrel, a flask of water, etc., in giving a child the fundamental ideas that govern the distribution and classification of the three great kingdoms of nature. The spirit manifested by the teachers present was evidently very gratifying to the lecturer, and he referred to it twice. If it had not been for their willingness to enter into and help work out the questions, the lecturer would not have succeeded. As it was, so large an audience, about five hundred teachers, was probably never before successfully handled by one man in object teaching. All who are engaged in this experiment, as it was called by the President of the society, have reason to congratulate themselves upon so auspicious a beginning."—*Boston Transcript*.

We learn from one of the committee that they have long recognized the hopelessness of attempting to work upon the public at large by means of the usual lecture system. However effectual this may be as a means of cultivating a taste for natural science, it certainly does not produce any very definite or encouraging results. Collateral study and practical work with specimens are essentials without which mere lectures are very barren to the majority of minds. They have therefore concluded that their efforts should be concentrated upon the public system of education, and here they have been nobly seconded by the teachers, who have come forward to the number of seven hundred and fifty, while an average of nearly six hundred have actually been in attendance at the lectures, which have been given by Prof. W. H. Niles upon physical geography. On this subject the whole class of teachers can be instructed at once, but in subsequent courses upon mineralogy, zoology and botany, it is proposed to divide them into

smaller classes, so that each teacher will be able to use specimens and carry out completely the system of object teaching. The committee hope by so doing, and furnishing the schools, wherever practicable, with type specimens, to meet the immediate wants of teachers, and by introducing them to practical laboratory work, to induce them to pursue for themselves some special branch of natural science. The committee have been greatly assisted in their efforts by the masters of the public schools, especially the chairman of the masters' committee, Mr. Paige, and also by the superintendent of public instruction, Mr. John D. Philbrick. The experiment owes its support at present entirely to the generosity of one of the committee, Mr. John Cummings.

The aims of the committee (consisting of John Cummings, Esq., and Professors A. Hyatt and W. H. Niles) who have projected the entire movement, are wholly practical and will be to a large extent governed by experience. They intend if possible to meet the daily wants of the teachers now, and in the coming winters of 1872 and '73 to develop such a plan as will insure the permanent introduction of the teaching of natural science in the public schools of Boston at least.

We congratulate the Boston Society on so successful an inauguration of science teaching, and believe that it has assumed the most practical form by which teachers can be fitted to teach the rudiments of science. We look forward to similar courses in other cities in connection with the local scientific societies, and thus a defect in our system of education will gradually be remedied.

We may divide the German Museums into—(1) Those founded with the intention of exhibiting objects of Natural History to the general public; and (2) those established for educational purposes. There are not many of the former class. To it belong the Museums of the formerly independent "Reichsstädte," Hamburg, Bremen, and Frankfort-on-the-Main, one of the Vienna Museums, and the collections in Stuttgart and Darmstadt. There are others like that in Mayence, but they have more the character of well-arranged local country museums. Although originally founded for the purpose of exhibiting curiosities, they soon took another position by receiving objects in which the general public takes a very limited interest (as, for instance, botanical, geological, or mineralogical specimens), and by systematically collecting materials for the

purposes of purely scientific research. In several instances the scientific results were sufficiently important and extensive to form not only a nucleus but the sole subject-matter of distinct periodical works, such as the "Annalen des Wiener Museums," the "Museum Senckenbergianum," the "Abhandlungen des Hamburger Museums." The Frankfort Museum became the head-quarters for the Zoology of North-eastern Africa; Bremen possesses a unique collection of African birds, celebrated not only for the great number of standard specimens, but also for their beautiful state of preservation. In the Vienna Museum particular attention was paid to European fresh-water fishes; and travellers like Natterer, Russeger, Kotschy, enriched it with collections so numerous that the Austrian naturalists have been engaged in their examination till within a very recent period. The Stuttgart and Darmstadt Museums are now celebrated for their valuable collections of South-German fossils, worked out by G. von Jäger, Kaup, and others.

In the museums of this class great attention is paid to the local flora and fauna, recent and extinct. Thus the Stuttgart collection may be mentioned as a model of what a museum ought to be; besides a most complete series of the plants and fossils, it contains a collection of the animals of Suabia in all stages of growth and development and of variation, in a perfect state of preservation and particularly attractive from the life-like manner in which the specimens are mounted. — *Nature.*

The Middletown Scientific Association, accompanied by the members and friends of the Springfield Association made an Excursion to Rice's Cut, Reed's Gap and Hamilton Mountain, on Saturday, October 28th. On this excursion, the party numbering about one hundred had an opportunity to observe some of the most remarkable phenomena connected with the trap rocks of the Connecticut Valley, and enjoyed one of the finest views in the vicinity.

The Secretary of the Boston Society of Natural History, Rev. J. A. Swan, died late in October. He was much beloved as a man, and his scholarly attainments and zeal for natural history, made him an efficient officer. His successor has not yet been appointed.

It is stated that Prof. Raphael Pumpelly has been appointed State Geologist of Missouri. Another report states that Prof. Swallow received the appointment. Which is correct?

Prof. E. Claparède, the eminent zoologist of Geneva, died on the 2d of June, at Sienne, Tuscany. He had not yet reached his fortieth year. By his anatomical and systematic works on the lower animals, especially the worms, and illustrated with his facile pencil, he had attained the front rank as an investigator, and his death is a serious loss to science. His principal works were on the Evolution of Spiders, Studies on the Infusoria and Rhizopods, the Formation of the Egg in Nematode Worms, Studies on Acarina, and his splendidly illustrated works on the anatomy of the Worms. He was a pupil of Johannes Müller, and besides a high order of talent, must have been endowed with great powers of application to have produced so much.

We are glad to announce that the Chicago Academy of Science have resumed their meetings and that the members are resolved to go on with their good work at once. At the meeting on Nov. 14, Col. Foster read a paper on the "Colorado Mountains" which will be printed in our January number. Mr. Walker in behalf of the Trustees of the Academy made an informal announcement to the meeting that the Academy would have left from the fire about sixty thousand dollars with which to rebuild, and trusted that a lot would be secured near the lake shore.

BOOKS RECEIVED.

Das Innere von Grønland. Von Dr. Robert Brown. 4to. 1871.

Beretninger om Norges Deeltagelse i den almindelige Industri—Udstilling og Kunst—Udstillingen i Stockholm 1866, *og Paris* 1867. 8vo. Christiania, 1869.

Carcinologiske Bidrag til Norges Fauna. Af G. O. Sars. I. Monographi. Mysider. 4to. 5 plates. Christiania, 1870.

Om Skuringsmærker Glacialformationen og Terrasser samt om grundfjeldets og sparagmitfjeldets mægtighed i Norge. *J. Grundfjeldt.* Af Prof. Theodor Kjerulf. 4to. Kristiania. 1871.

Kart over Christiania Omegn med Randtegninger. 1871.

Le Neve de Justedal et ses Glaciers par C. de Seue [with map and photographic plate of glaciers]. 4to. Christiania, 1870.

Bidrag til Lymphekjertlernes normale og pathologiske Anatomi. Af A. Hansen. 4to. 5 plates. Christiania, 1871.

Meteorologiske Iagttagelser det Sydlige Norge, 1863-6. Folio. Christiania, 1867.

Meteorologiske Iagttagelser paa fem telegrafstationer ved Norges kyst. Folio. Christiania, 1866.

On a Method of Registering Natural History Observations. By Alfred Newton. 8vo. pp. 11, with sample sheet. Norfolk, 1870.

Characters of New Species of Birds collected by Dr. Habel in the Galapagos Islands. By P. L. Sclater and Osbert Salvin. 8vo. pp. 8. Cuts. London, 1870.

American Journal of Conchology, Vol. 7, *No.* 2. Philadelphia. [Nov. 24, 1871.]

Fossil Plants of the Devonian and Upper Silurian Formations of Canada. By J. W. Dawson. 8vo. pp. 100, 20 plates. Geological Survey of Canada. Montreal, 1871.

Bulletin Mensuel de la Societe d'Acclimatation. 2e. Tom. 8. Nos. 9, 10. Oct., Nov., 1871. Paris.

On the Connecticut Valley Glacier, and other Examples of Glacier Movement along the Valleys of New England. By James D. Dana. 8vo. pp. 12. New Haven, 1871.

Plantas Toxicas do Brasil. These de Concurso. Do Dr. J. M. Caminhoa. 8vo. pp. 186. Rio de Janeiro, 1871.

Quarterly Journal of Microscopical Science. No. 45. Oct., 1871. London.

Bulletin of the Torrey Botanical Club. Nov.

Journal of the Franklin Institute. Nov.

Amer. Journal of Science and Arts. Dec.

Land and Water. Nos. for Oct.

The Academy. Nos. for Nov.

La France Scientifique. Nos. for Nov.

Bowdoin Scientific Review. Nov.

Le Naturaliste Canadien. Nov.

Nature. Nos. for Nov.

The Field. Nos. for Nov.

Science Gossip. Nov.

Newman's Entomologist. No. 97, Nov.

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